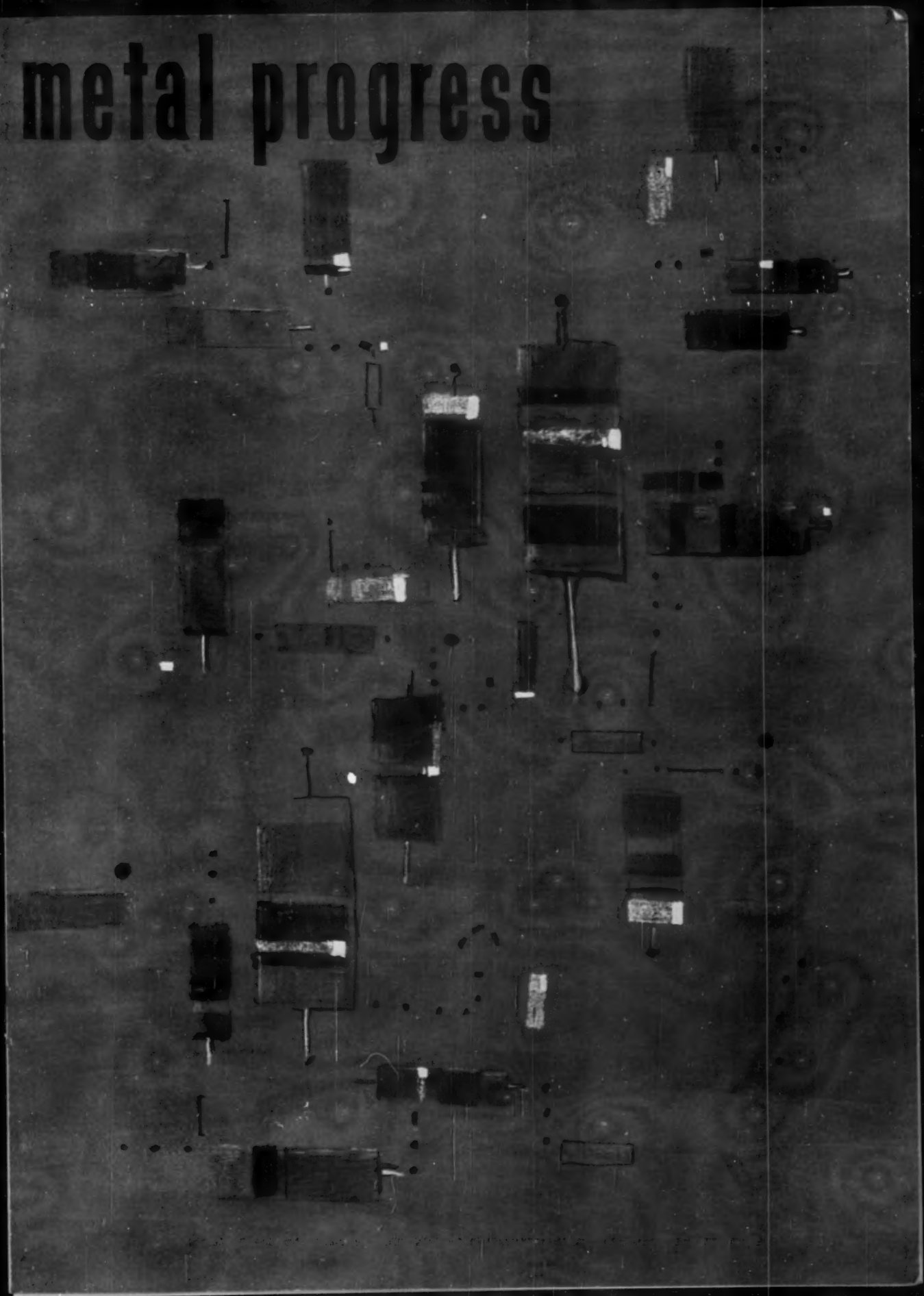
metal progress



Progress with **TITANIUM**



J-57 compressor rotor, operating at several hundred degrees F., uses discs, blades and other parts of MST 6Al-4V titanium alloy.

MORE THRUST PER POUND

Teamwork of specialists applies titanium alloy to improve mightiest U.S. jet engines

The bold use of new materials is one of the reasons for the preeminence of Pratt & Whitney Aircraft's J-57, and newer J-75 jet engines.

The MST 6Al-4V titanium alloy, which Mallory-Sharon helped develop and introduced commercially, is used in quantities of hundreds of pounds to increase the thrust-per-pound ratio of these engines. This alloy meets the rugged conditions of stress and temperature in engine use.

Mallory-Sharon, one of the first materials producers for this engine, supplies the MST 6Al-4V alloy to various specialists for fabrication . . . Ladish Co. and Wyman-Gordon Co. for spacer and disc forgings . . . Thompson Products, Inc., Eaton Manufacturing Co., Steel Improvement & Forge Co. for blades and other parts . . . which are all furnished to Pratt & Whitney Aircraft.

Let Mallory-Sharon, technical leader in titanium, help *you* apply this new metal. It has the strength and lightness needed in engines and aircraft, the superior corrosion resistance demanded for chemical processing equipment. Write for information.

MALLORY Ti SHARON

MALLORY-SHARON TITANIUM CORPORATION · NILES, OHIO

Producers of titanium and titanium alloy sheet, strip, plate, rod, bar, billets

Metal Progress

Volume 72, No. 3

September . . . 1957

HAROLD J. ROAST
E. C. WRIGHT
J. L. McCLOUD
TOM BISHOP
Consulting Editors

ERNEST E. THUM, *Editor*

MARJORIE R. HYSLOP, *Managing Editor*

FLOYD E. CRAIG
Art Director

DAVE RITCHIE
Assistant Editor

"Transistor" Cover by JACK JOHNSON, student at Cleveland Institute of Art.

Engineering Articles

Extrusion of a Complex Shape Through a Round Die, by William E. Ray 65

A long, straight control rod of Y-shaped cross section for a nuclear reactor is made by canning flat cermet compacts, assembling them with appropriate inserts of soft steel to fill a sealed sheath, hot extruding the combination, and then dissolving the soft steel inserts in acid, leaving the required stainless-clad rod. (T11j, 17-7, F24; SS, Eu, 8-16)*

Bright Heat Treating the Nonferrous Alloys, by Clarence E. Peck 70

Atmospheres are specified for successful bright annealing of the principal nonferrous metals and their alloys, to avoid dezincification of brasses, and to protect properly powder metal compacts during sintering, or combinations during furnace brazing. (J2k, J23a, H15q, K8; EG-a38)

Casting Large Ingots of Uranium, by G. W. P. Rengstorff and H. W. Lownie, Jr. 76

Sound ingots, 7 in. diameter, weighing 1200 lb. and with 91 to 95% recovery in metal, can be cast in iron molds after induction melting the uranium "derbies" in magnesia or graphite crucibles under open argon atmosphere. (C5j, 1-2; U)

Relief of Residual Grinding Stresses by Annealing, by H. R. Letner and A. B. Sauvageot 79

Momentary heating of the surface (no more than 90 sec. in salt bath) at 650° F. will relieve 80% of the internal stresses left by grinding. If softening of more than 1 point on the Rockwell scale is prohibited, 90 sec. at 500 to 600° F. will remove about half the surface stresses. (J1a, G18, TS)

Multi-Purpose Heat Treat, by E. A. Schoefer 83

Two in-and-out batch-type carbo-nitriding furnaces, a washing machine, unique arrangements of roller conveyers and extensive use of high-alloy castings (Type HT) form a combination suitable for hardening small parts made of various types of steel and cast iron. (W27g, 1-2, W27p, 17-7; SCA-h,5)

Scrap in Deep Drawing Reduced 90%, by C. Kenneth Divers 88

Manufacture of wheel disks and hub caps of brass, stainless, and steel strip with minimum press room scrap has been correlated with preliminary tests on Olsen cup tester. Criteria are load to produce necking and corresponding height of cup. (Q23q, 1-4, G4b; Cu-n, SS, CN)

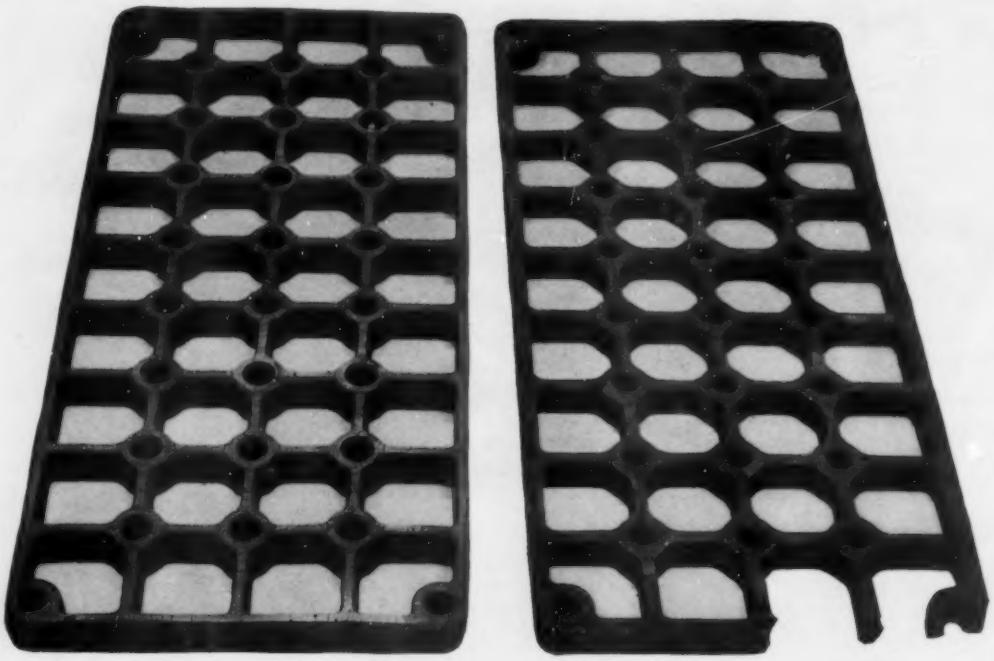
Table of Contents Continued on Page 3

METAL PROGRESS is published monthly by the AMERICAN SOCIETY FOR METALS. Publication office, Mt. Morris, Ill. Editorial, executive and advertising offices, 7301 Euclid Ave., Cleveland 3, Ohio. Subscription $7.50 a year in U.S. and Canada; foreign $10.50. Single copies $1.50; special issues $3.00 . . . The A.S.M. is not responsible for statements or opinions in this publication.

Requests for change in address should include *old* address of the subscriber; missing numbers due to "change of address" cannot be replaced. Claims for nondelivery must be made within 60 days of issue. No claims allowed for overseas subscribers. Entered as second-class matter at the Post Office in Mt. Morris, Ill. Copyright, 1957, by the AMERICAN SOCIETY FOR METALS.

**The coding symbols refer to the ASM-SLA Metallurgical Literature Classification, Revised Edition, 1957*

THE TALE OF TWO TRAYS





THERMALLOY TRAY—hot acid etch made after removal from service. Note that through proper chilling and foundry practice, most cracks are superficial.



COMPETITIVE TRAY—hot acid etch after failure shows severe shrinkage and cracking. This tray was in service *less than half* as long as the Thermalloy tray.

THERMALLOY* QUENCH TRAY
GIVES TWICE THE SERVICE LIFE

At a major automotive plant, two sets of quench trays were recently ordered for carburizing shafts at 1650 F. Both were of standard design. One set was cast by Electro-Alloys of Thermalloy heat-resistant alloy—the other was a competitive make.

The illustrations above clearly show the condition of the two test trays . . . after the Thermalloy trays had been in service *more than twice as long* as the competitive make. Use of chills at critical points and proper foundry technique in the Thermalloy trays accounted for their much longer service life . . . by eliminating the shrinkage evident in the competitive tray. This test, made by the customer, clearly proved the added quality and strength achieved through the use of chills.

Whatever *your* heat-treat problem, it pays to make use of Electro-Alloys casting know-how—plus the outstanding physical properties of Thermalloy high-heat-resistant alloys.



For further technical information on Thermalloy Heat-Treat Trays, write for Bulletin T-227 . . . Electro-Alloys Division, 8039 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY **ELECTRO-ALLOYS DIVISION** Elyria, Ohio

Metal Progress

Contents Continued

Two Promising New Titanium Alloys, by S. Abkowitz and Dillon Evers 97

An alloy with 2.5% Al and 16% V is readily formable and then age hardened to 160,000 psi. yield strength retaining 5% elongation. An alpha alloy with 8% Al, 2% Cb and 1% Ta is weldable in bar and sheet form and extends the temperature limit of usefulness 200° F. over conventional alpha alloys. (Q23q, Q27a, Q3m, 2-12, 2-14; Ti)

Superpurity Nickel Melted Under Controlled Atmospheres, by K. M. Olsen 105

Research work on vacuum tube repeaters for transoceanic cables requires nickel of unexampled purity. This can be made by melting sintered slugs of carbonyl nickel powder in magnesia crucibles under a definite program of hydrogen, vacuum and helium atmospheres. The process is also effective for high-purity binary nickel alloys and iron alloys. (C5j, Ni-a)

Atomic Age

Controlled Thermonuclear Reactions 92

Excerpts from 22nd semi-annual report of the Atomic Energy Commission to the Congress, July 31, 1957.

Data Sheet

Nomograph for Rate of Strain, by Wm. H. Mather 96-B

Designed for getting a close approximation of strain rate in mechanical testing. Examples of use of the nomograph given on p. 96.

Book Review

Humanity and the Atom, reviewed by Ernest E. Thum 103

"Atomic Quest, a Personal Narrative" tells the fascinating story of events and persons involved in the development of atomic energy. The author, Arthur Holly Compton, also relates the soul-searching and moral problems that the scientists had to grapple with.

Short Runs

Resistance Wire Improved by Vacuum Melting, by Charles G. Gilbart 93

Temperature coefficient of resistance for Ni-Cr wire can be reduced from $\pm 50 \times 10^{-6}$ per ^{0} C. to $\pm 10 \times 10^{-6}$.

Portable Spectrometer for Identifying Metals, by Louis E. Owen and Robert F. O'Connell 94

Particularly useful for identifying critical components on large fabricated assemblies in the field.

Explosion of a Titanium Crucible, by Clo E. Armantrout and June R. Hauger 94

A laboratory accident points up the danger of using titanium in contact with highly oxidizing substances, even at moderate temperatures.

Etchant for Stainless Type 403 Forgings, by Richard D. Buchheit 95

Electrolytic etch develops flow lines.

Rate of Strain Nomograph, by Wm. H. Mather 96

Correspondence

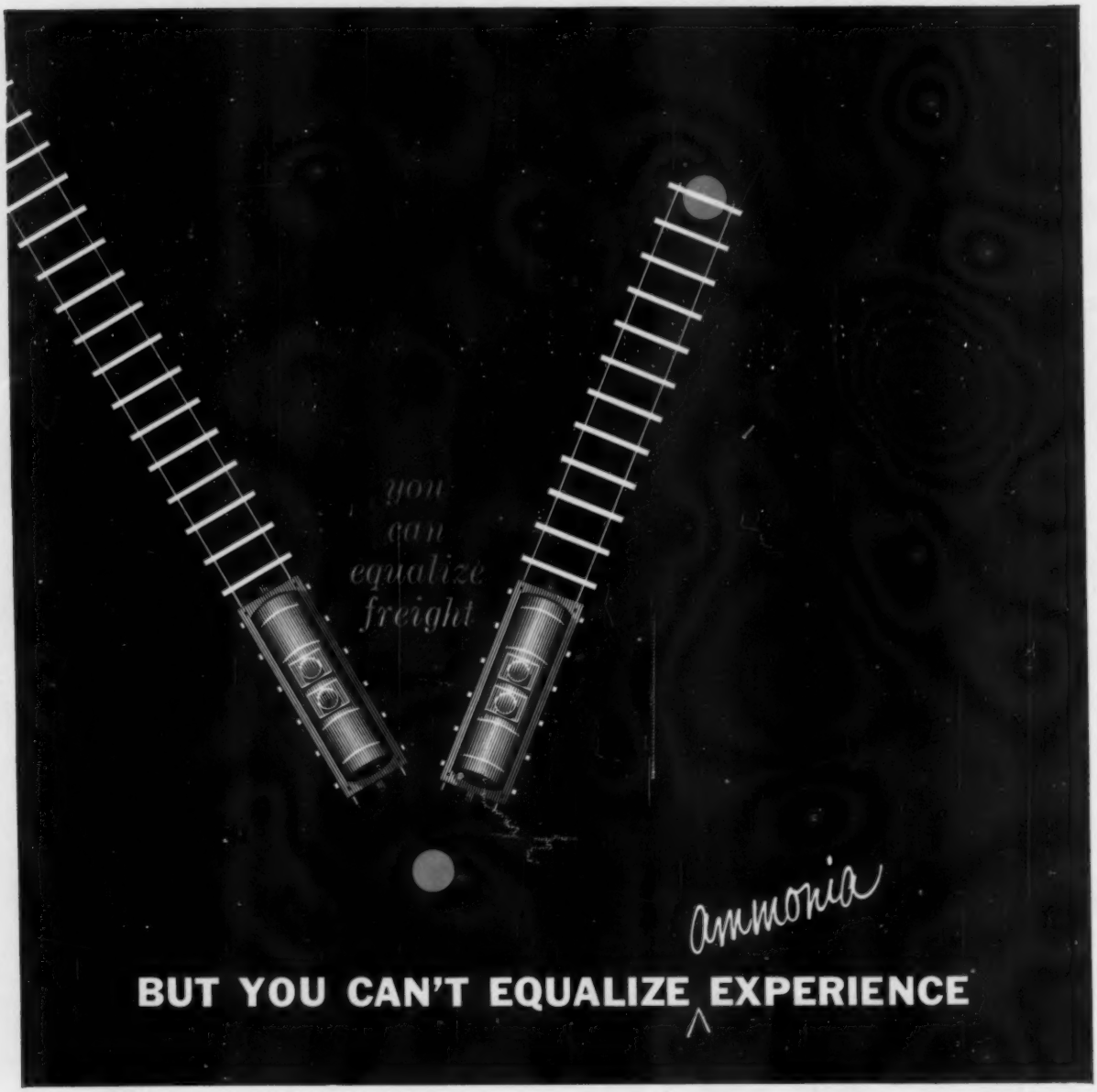
Phase Diagrams for Oxidation of Metals, by E. H. Bucknall 110
Hardenability Test for Deep Hardening Steels. by William Wilson, Jr.; Carl M. Carmen 114
Timely Review of Metal Literature, by Myron Weiss 118

Digests of Important Articles

Oxygen Cutting of Titanium 154
Creep Resisting Steels for Steam Power Plants 156
Weight Losses of Various Alloys in Titanium Tetrachloride 160
Modern Basic Bessemer Process 170
Study of Wear Process 176
The Mechanism of Craze-Cracking 178
Sulphidizing in Fused Salts 182
Dimensional Instability of Turbine Shafts 184
Effect of Fatigue Cracks on Static Strength 186
Pressure Die Casting in Vertical Hydraulic Press 190
Effect of Vibration on Casting Quality 192
Rapid Heating of Forgings 196
Special Steels for Turbine Generators 200
Increasing Blast Furnace Output 210
Particle Size Analysis 216

Departments

As I Was Saying, by Bill Eisenman 5
Application and Equipment – New Products 19
Application and Equipment – New Literature 37
Personals 120
Advertisers' Index 264



No, you can't equalize experience! And Allied's Nitrogen Division is *FIRST* in ammonia experience. Years of pioneering better production methods, of helping users solve all kinds of technical problems . . . these things don't always show up in customers' costs or product analysis. But they're a real plus value to ammonia users. For assured delivery, expert technical assistance and a product of uniform high purity, always specify Allied ammonia.

AA4-16-2

Allied Chemical — Nitrogen Division

40 Rector Street, New York 6, N. Y.

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements

As I was saying...



IT WAS IN September 1930 when the A.S.M. was holding its twelfth Congress and Exposition in the Stevens Hotel (now Conrad Hilton) that there was presented to the membership and to the publishing world a new magazine that was to be credited with inaugurating a revolutionary transformation in the general makeup and appearance of all magazines serving the metal industry. The paper, the halftones, the type face, the extra size page, the art covers, the page layouts all served to present a finished, harmonious and artistic magazine called *Metal Progress*.

Please do not think we live in the past—but it's only fitting and proper that on certain anniversaries we should halt and pay our respects and compliments to the many members of the A.S.M. who have contributed articles to its editorial pages; to Ernest Thum, efficient and sharp editor since its first issue; to clever Marjorie Hyslop, since its first issue the editor's secretary and later (1953) the managing editor; and to Peter Ford, who started on the lower rung and is now at the top as sales and advertising manager. All three were at Chicago 27 years ago to receive the accolades and observe the astonishment of the recipients of the "Fortune of the Metals Industry". Others have been added to the staff as the paper grew: Taylor Lyman, as publisher; also contributing editors and editorial assistants as listed on the masthead on page one.

To all the good people who have been and will be contributing to the continued success of *Metal Progress*, the A.S.M. sends Happy Birthday greetings. As you turn the pages of *Metal Progress* in the years to come may you continue to record the splendid engineering and well-organized material you have served so faithfully and intelligently in the years gone by.

● ● ●

Next month is going to be a busy one for everybody at headquarters and many members of A.S.M. All are striving to make the Second World Metallurgical Congress a great success. As you all recognize, we have a very high standard to equal and surpass in the activities and results of the first W.M.C. held in Detroit in 1951.

The 300 overseas conferees will assemble in New York on Oct. 17 for briefing and registration. Then on Monday, after a "Welcome to America" Luncheon at the Waldorf, the eight groups will set out on a two-weeks jaunt to visit plants (some 70 in all) between New York and Chicago. The technical activities start on Saturday, Nov. 2, and continue through Friday, Nov. 8, ending with the banquet "ASM Bids You Farewell" with the Overseas and American Conferees at the Palmer House that evening (when the Congress will come to an end).

I cannot urge you too strongly to attend the Congress. It will be at least five years before the third W.M.C. will be held. The full program will be in October *Metal Progress*, *Metals Review* and also in *Metal Showman*.

● ● ●

I've been jumping around quite a bit. I've covered hastily the past, the present and now a word for the future. If anyone believes we are living in the past and enjoying the present he need only read again the "A.S.M. of Tomorrow". The headquarters building is almost ready for the contractors; the Metals Engineering Institute has increased its staff, and 14 courses will be completed by Jan. 1, 1958; the Metallurgical Seminars are developing; the Research Institute and the Metal Science Institute (University) are all being clearly outlined and programmed.

As an ASMer you have an important part in the future of your Society. The A.S.M. has attained its present favorable stature because of your help and cooperation. We are confident you have set your sights up and forward so that success for the A.S.M. of Tomorrow will surely be attained.

Cordially yours,

Bill

W. H. EISENMAN, *Secretary*
AMERICAN SOCIETY FOR METALS

Looking for
HARDNESS TESTING FACTS?



Get this free catalog

Catalog contains complete details on all types of Brinell Hardness Testers . . . for laboratory, or production: Dead Weight, Hydraulic, Hand or Motor Operated, Large or Small, Standard and Special.

Since 1914

Sales Offices in all metalworking areas.

Steel City Testing Machines Inc

8811 Lyndon Ave., Detroit 38, Mich.

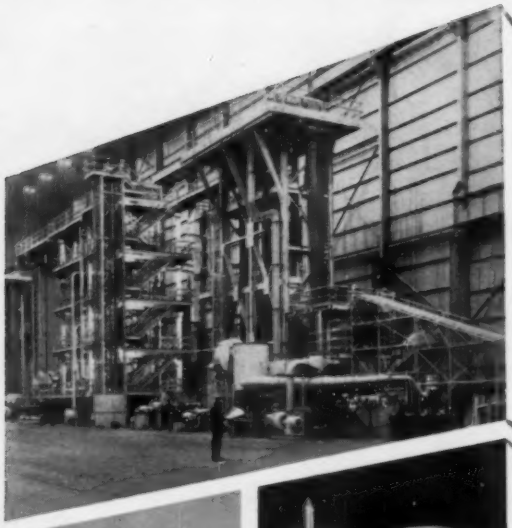
Mail this coupon for above Brinell Catalog. Check interest below on other types of testing machines.

Ductility ☐
Tensile ☐
Compression ☐
Tranverse ☐
Hydrostatic ☐
Proving Rings ☐
Flex-Tester ☐

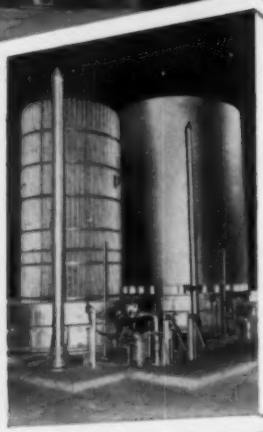
NAME_____

ADDRESS_____

Attach coupon to your letterhead and mail.



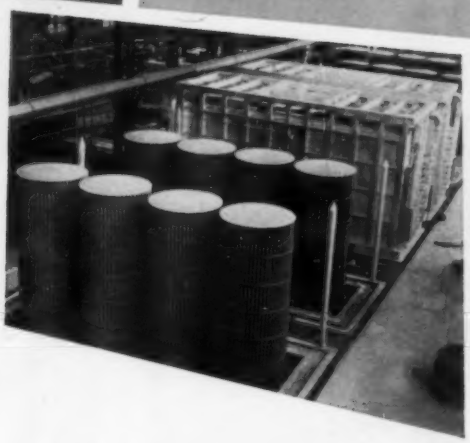
VERTICAL STRIP ANNEALER



SINGLE-STAND ANNEALERS

CONTINUOUS STRIP GALVANIZER



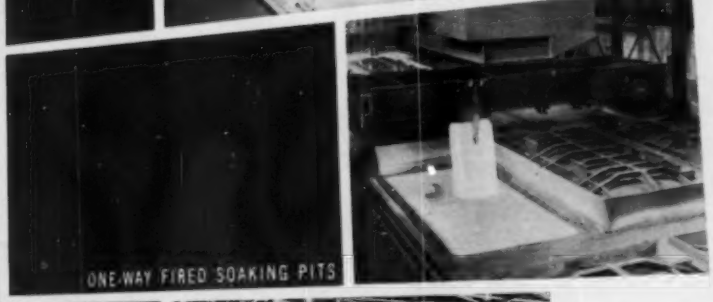


MULTIPLE-STAND ANNEALERS

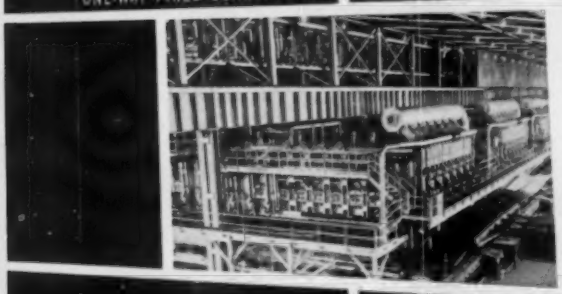
foundation for steel mill profits



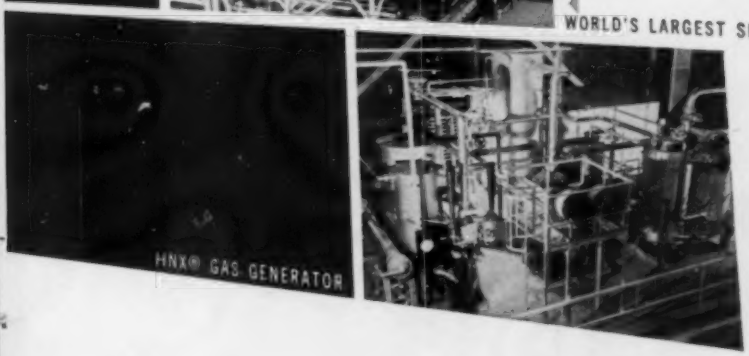
CARBOTTOM COVER FURNACE



ONE-WAY FIRED SOAKING PITS



WORLD'S LARGEST SLAB HEATER



HNX® GAS GENERATOR

You put a solid foundation under your profits whenever you specify Surface equipment. Whatever type it may be, you know it is supported by many interlocked blocks of know-how in heating and handling steel.

The technical skills which Surface has developed in building soaking pits will benefit the man who buys Surface annealing covers. In the same way, Surface concepts of slab heating contribute to high-speed stress relieving . . . carbon restoration to strip annealing . . . controlled atmospheres to wire patenting.

Because of this broad and deep foundation of experience, Surface can improve any single process in the context of a complete sequence of operations. This is to the customer's profit, as many companies will confirm.

Surface Combustion Corporation, 2410 Dorr St., Toledo 1, Ohio. In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ontario.

Surface®

wherever heat is used in industry

ASSOCIATED COMPANIES: British Furnaces, Ltd., Chesterfield • Stein & Atkinson, Ltd., London • Stein & Roubaix, Paris • S. A. Belge, Stein & Roubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka • Benno Schilde Maschinenbau, A. G., Bad Hersfeld



Big Ingot Reduction Contributes to Superior Quality Stainless Steel at J & L

The quality of stainless steel is assured at the J & L Stainless Steel Division because the large capacity furnaces permit the pouring of larger ingots. For example: When an ingot is cast, its structure is coarse and its grains are exceptionally large. To develop greater strength, it must be "hot worked" into blooms or billets; and because of the larger ingot size, J & L is able to roll ingots to blooms or billets with more reduction than is the normal practice in most mills. The result is sound, pipe-free centers, finer grain and more uniform structure.

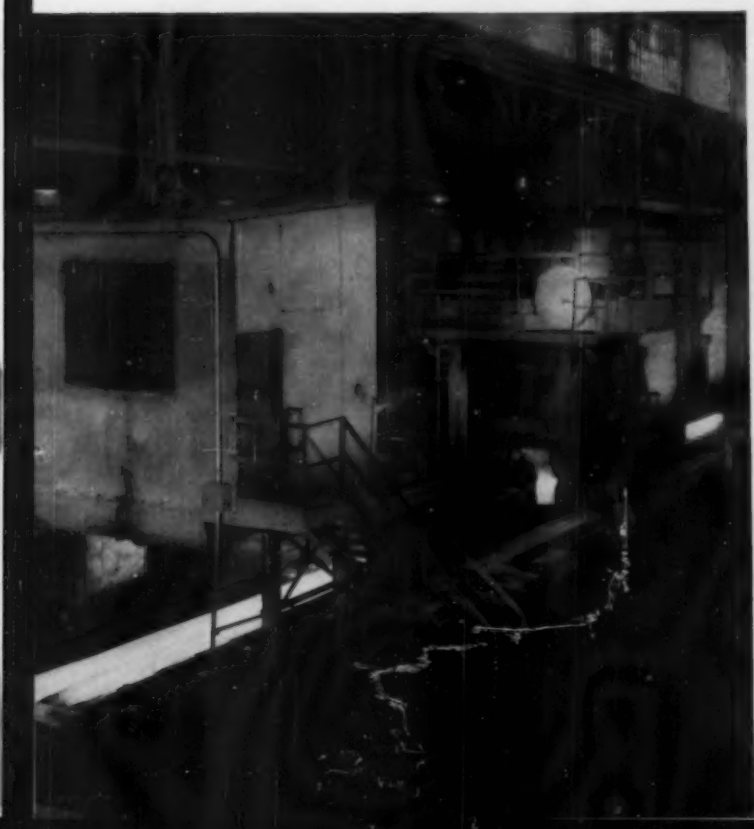
This is just one more factor—one more facility—contributing to the continuing effort at the Stainless Steel Division of J & L, to bring to its customers the highest quality stainless steel available.

Ready-to-ship Inventory Adds a *Plus* to Quality

Quality, plus the ability to ship a wide range of stock *immediately*, is an unbeatable combination. A stock of hundreds of tons of finished stainless bars is now available from our storage facilities. Write for our latest stock lists, or for quotations on finished bars or billets.

J&L STEEL

Jones & Laughlin
STEEL CORPORATION
STAINLESS STEEL DIVISION
Box 4606 • Detroit 24, Michigan
FORMERLY ROTARY ELECTRIC STEEL CO.





Stop heat losses with

VEGALITE
Unique silica insulating brick. For service up to 3000° F.



H-W 30
Maximum service temperature 3000° F.



H-W 28
Maximum service temperature 2800° F.



H-W 26
Maximum service temperature 2600° F.



H-W 23
Maximum service temperature 2300° F.



H-W 20
Maximum service temperature 2000° F.



H-W 16
Maximum service temperature 1600° F.



Seven distinct types afford four-way savings

1. Savings in fuel

The use of Harbison-Walker insulating fire brick greatly reduces heat losses and the amount of heat stored in the brickwork during operation, which causes loss of heat when the furnace is shut down.

2. Savings in time

With Harbison-Walker insulation the time required to bring the furnace to operating temperature is materially reduced. This is a distinct advantage when furnaces are operated intermittently.

3. Savings in space

Insulated furnaces may be built closer to each other without affecting the comfort of the workmen. This not only permits more efficient handling but also reduces capital expenditures for floor space.

4. Savings in weight

The reduction in weight of the furnace refractory structure often permits the use of a lighter foundation and lighter steel members in the form of buckstays, tie rods and other furnace bindings; also lighter door frames, doors and counter balance mechanisms.

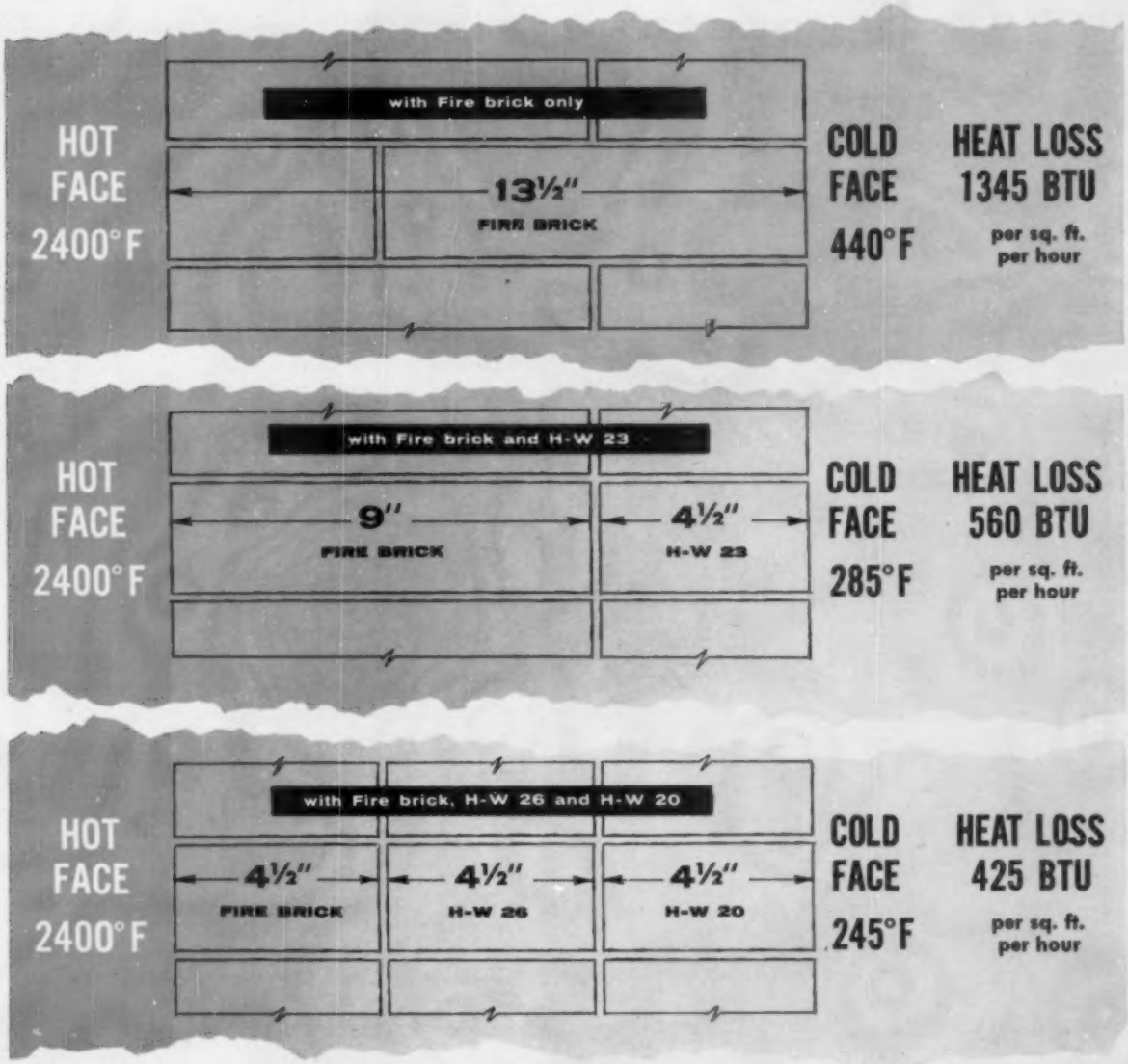
HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES



General Offices: Pittsburgh 22, Penna.

World's Most Complete Refractories Service

Harbison-Walker Insulating Fire Brick



These furnace sections show how heat losses are reduced by using Harbison-Walker Insulating Brick for backing fire brick furnace walls. The heat loss is reduced 58.4% in one case and 68.4% in the other. These are typical of savings that are frequently experienced.

In addition to savings in fuel, floor space and weight, the use of insulating brick provides for faster heating and in some instances reduction of noise.

To assure best overall results, it is important that insulating refractories be carefully selected to secure the most advantageous combination of properties. Harbison-Walker having the full complement of both insulating and refractory brick, can furnish the correct combination for any requirement.

Harbison-Walker insulating brick have the balanced properties that mean dependable service. Light weight, essential to high insulating value and low heat-storage capacity, have been obtained to the greatest degree, consistent with the mechanical strength necessary for handling and for durability in service.

Harbison-Walker insulating products also include LOTHERM, the extra strength insulating fire brick; H-W Lightweight Castables; H-W Block Insulation and H-W Mineral Fiber Coatings.

Write for the H-W bulletin containing comprehensive engineering data.

1 Water-cooled power cables.

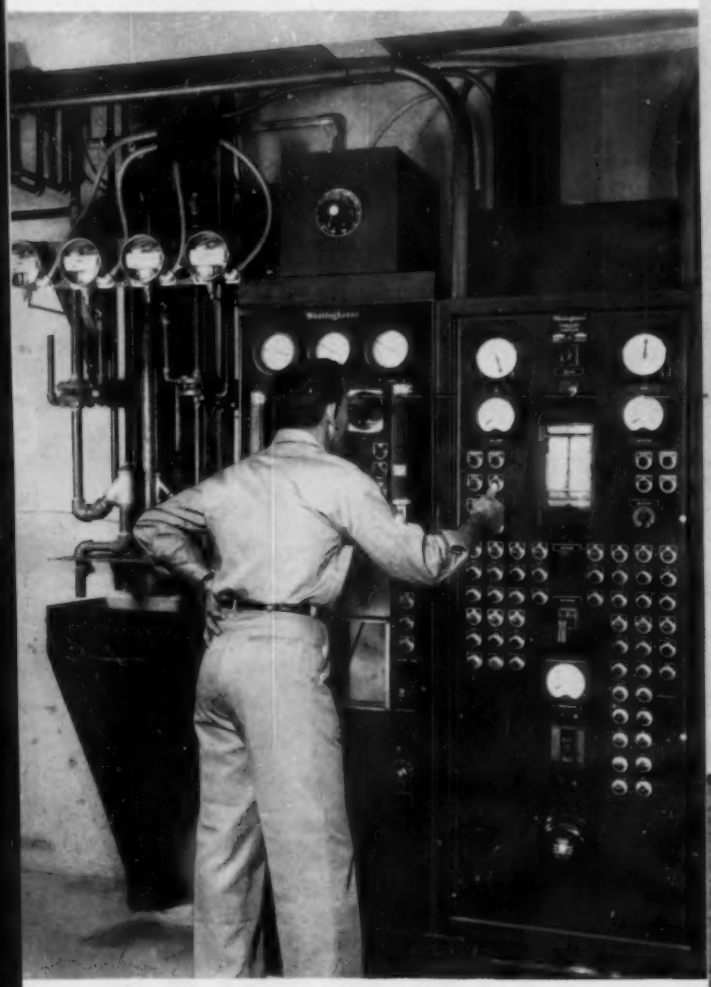
2 Electrode holder.

3 Vacuum-tight seal for electrode housing.

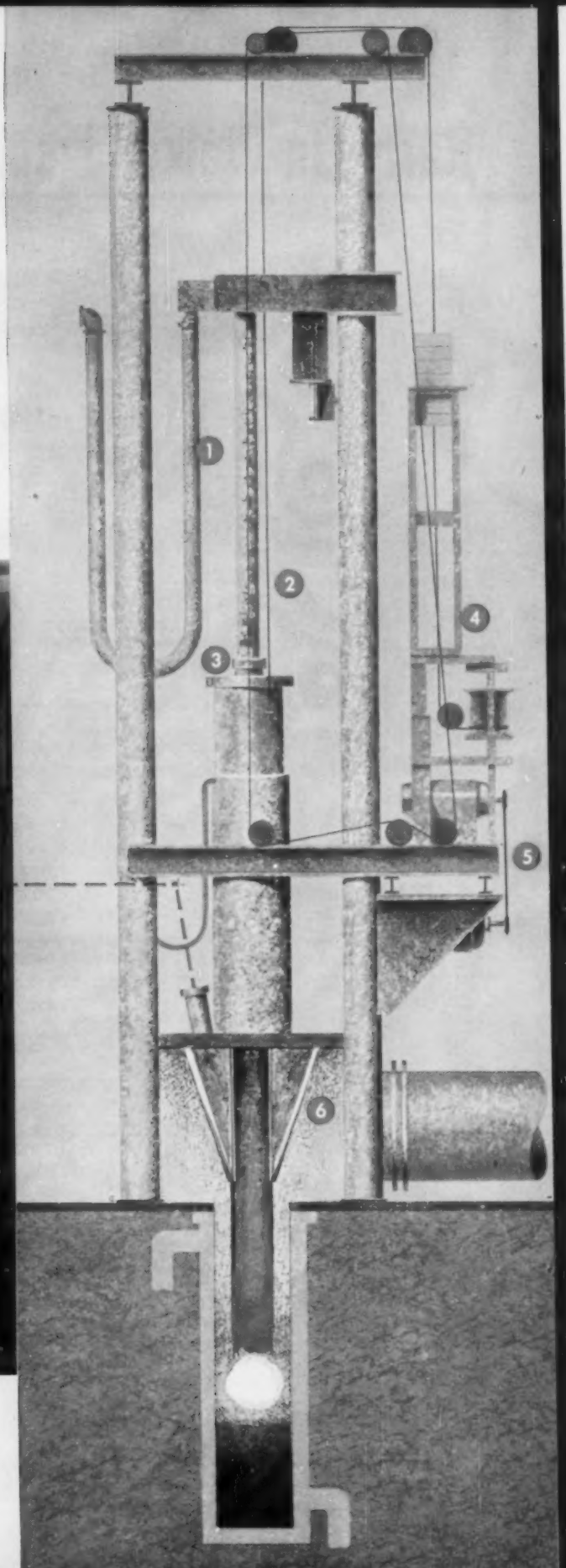
4 Lifting mechanism for electrode housing.

5 Automatic electrode position drive.

6 Electrode guides.



Automatic control panel sequences and monitors vacuum arc furnace operation. Built-in optical system allows operator to observe melting progress.



Westinghouse installs largest vacuum arc furnace at Carborundum Metals Company

Tough requirements for melting large, zirconium ingots have been minimized at Carborundum Metals Company by a new Westinghouse vacuum arc furnace. This furnace produces 8″ or 12″ first-melt ingots and 12″ or 16″ double-melt ingots up to 2200 lbs. Top metallurgical functioning results from careful design and construction.

Furnace design is backed by extensive vacuum chamber research. This work developed methods for controlling the action of an arc in high vacuum. At Westinghouse Metals Pilot Plant these laboratory conclusions were scaled-up in production size melts. Ingot analysis verified furnace design and operating procedure.

Careful attention was given to electrical and mechanical components, too. Power cables are permanently connected for positive electrical contact. Electrode movement is governed by positive downward drive, and a positioning mechanism guides the electrode on true center. All drive components are externally mounted for easy inspection.

Capable of every step from research to equipment manufacturing, Westinghouse can be a single source for *your* vacuum metallurgy needs. It's another example of the way Westinghouse helps you POWER-UP . . . to get better production and profit from your electrical dollar. Talk it over with your Westinghouse Industrial Heating representative or write Westinghouse Electric Corporation, Industrial Heating Division, Meadville, Pa.

J-10465



Accurate electrode centering is maintained by fixed guides; sound construction provides added safety.



Sturdy ingot molds, ranging from 8 to 16 inches in diameter afford simple installation . . . large cooling water connections . . . arc stabilization connections.

YOU CAN BE SURE...IF IT'S

Westinghouse

Range-burner manufacturer does

REPUBLIC ELECTRUNITE



REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

everything but tie knots in this STEEL TUBING

First, there's a hairpin bend to a 1¼-diameter radius! Then a 4-way crimp to form a finned venturi! Next some punching and notching! Followed by welding!

This is how Harper-Wyman Company turns Republic ELECTRUNITE® Carbon Steel Tubing into the lightweight, easy-to-clean venturi burner tubes used on scores of famous-name gas ranges.

All these severe bending and crimping operations depend on close tolerances on the O.D. and the I.D. of the Republic Steel Tubing to avoid die and mandrel troubles. Uniform, predictable ductility is a must to avoid stretch and collapse as the tubing is severely bent and formed.

Republic ELECTRUNITE Steel Tubing is uniform in wall thickness, fully concentric, and can be furnished with smooth surface finish inside and out. It is supplied in a full range of sizes, wall thicknesses, grades, and ductilities to meet any of your fabricating requirements. Dollar for dollar, your best tubing buy is Republic ELECTRUNITE, the *original* electric-resistance-welded tube.

Let our engineers help you design Republic ELECTRUNITE Steel Tubing into your products to speed production, cut costs, eliminate excess weight and improve product performance. Fill in coupon and mail today.



VOLLRATH COMPANY MAKES STAINLESS STEEL WASHER TUB IN ONE DEEP DRAW. For the Speed Queen automatic washer, Vollrath craftsmen start with a circular blank of Republic ENDURO® Stainless Steel. Then, in a single operation, they deep-draw the blank into a tub in which diameter of the blank is reduced 50%. Proof of ENDURO's ductility and workability! Installed in the Speed Queen washer, the stainless tub adds sales appeal, promises lifetime service. Where can you use ENDURO to improve product or process? Republic metallurgical help is yours for the asking.





TWO-YEAR-OLD DRIVER TESTS NYLOK NUTS. They are used at several critical points of the Taylor Tot manufactured by The Frank F. Taylor Co., assuring positive locking even under severe shock, vibration and tension. Republic Nylok Nuts lock whether seated or not, protecting painted surfaces and soft metals. Positive locking assured wherever you stop wrenching. Even a two-year-old can't shake 'em loose. Want test samples? Write Republic, indicating size needed.



GET ZINC COATING PROTECTION WITHOUT COSTLY DIPPING AFTER FABRICATION. You can, with Republic Continuous Galvanized Steel. That tight, corrosion-resistant zinc coating will not crack, flake or peel under any forming process permitted by the base metal. Result is long-lasting protection without costly dipping. And, further finishing can be eliminated. Get the facts on this new production-line material, available in sheets and in rolls. Send coupon today.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. C-3997
3188 EAST 45th STREET • CLEVELAND 27, OHIO

I'm interested in more information on:

- ☐ Republic ELECTRUNITE Mechanical Tubing
- ☐ Republic ENDURO Stainless Steel
- ☐ Republic Nylok Nuts
- ☐ Republic Continuous Galvanized Steel

Name_____ Title_____

Firm _____

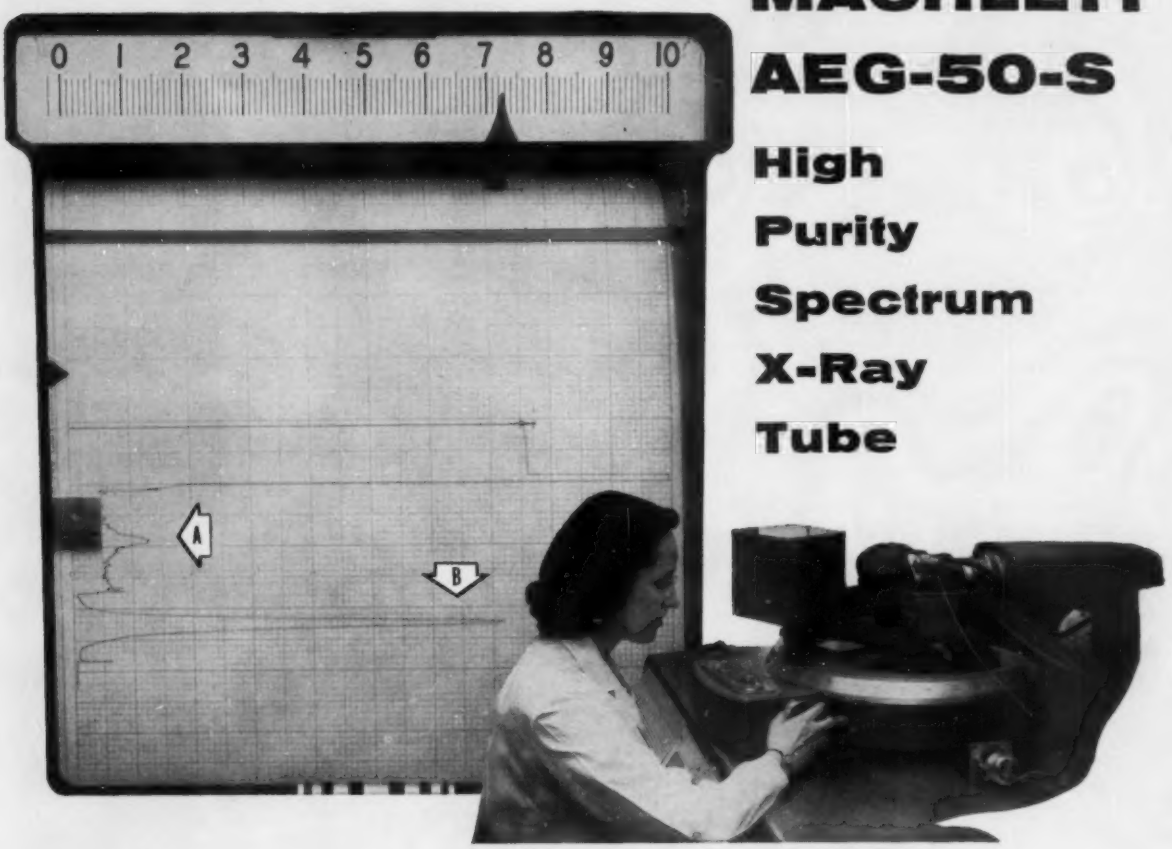
Address _____

City_____ Zone___ State_____

Bell Telephone Laboratories employs X-Ray Fluorescence Analysis using

MACHLETT AEG-50-S

High Purity Spectrum X-Ray Tube



In the Materials Analysis Laboratory of the Bell Telephone Laboratories, Murray Hill, New Jersey, x-ray fluorescence analysis is performed with equipment using the Machlett AEG-50-S high purity spectrum x-ray tube. Specimens, easily prepared, are irradiated by the high energy output of the AEG-50-S to produce the characteristic x-ray fluorescent spectra of the elements present. These spectra may then be readily analyzed.

The graphical data illustrated relates to an analysis of polyvinyl insulation to determine its possible corrosive effect on copper wire. The intensity of the sulfur line (A) is measured before and after a water immersion procedure; the amount of reduction in intensity of the sulfur line following the water extraction indicates the amount of soluble sulfur. Soluble sulfur (probably sulfates) may influence both corrosive properties and insulation resistance. In the example shown the extractable sulfur is too great; the lower peak (B) is that of an internal standard, chloride.

Machlett industrial and analytical x-ray tubes encompass the broad range of medium voltage x-ray usage. Tubes of all types are available for such uses as high power fluoroscopy, thickness gaging, diffraction analysis; general radiographic tubes are available for stationary and for a wide variety of portable equipments.

Write us for a complete description of our Industrial X-Ray Tube Line.

MACHLETT LABORATORIES, INCORPORATED • SPRINGDALE, CONNECTICUT

The New AUTOMET is on Display in our New Show Room and Laboratory Visit us for a Demonstration



This safety signal is saying:



"reduce load rate application!"

A test reading taken now would probably be erroneously low — or the machine might be running dangerously overloaded.

That's why Riehle's Electro-Balanced indicating unit always *buzzes a warning when a load is being generated on the specimen at a higher rate than a servo system can follow.*

This buzz tells the operator to reduce the load rate application. It prevents wrong readings or possible machine damage. This safest and most sensitive of all indicating units is offered for both hydraulic and screw power testing machines — by Riehle. It's a Riehle feature that gives users confidence in their test results.



Riehle TESTING MACHINES

A DIVISION OF

American Machine and Metals, Inc.

EAST MOLINE, ILLINOIS

NEW BULLETIN . . . MAIL COUPON

RIEHLE TESTING MACHINES
Division of American Machine and Metals, Inc.
Dept. MP-957, East Moline, Illinois

Please send your free 4-page Bulletin RU-14-56 with full data on the new Riehle Electro-Balanced Indicating Unit.

COMPANY _____

ADDRESS _____

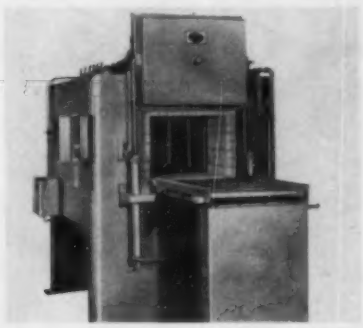
CITY _____ ZONE STATE

ATTENTION MR. _____

APPLICATION and EQUIPMENT new products

Controlled-Atmosphere Tempering

Two new controlled-atmosphere tempering units, with and without a cooling chamber, have been announced by Eclipse Fuel Engineering Co. Tempering operations can be maintained to a maximum temperature of 1400° F. with work being manually loaded into the heating chamber from a roller



platform. Work area in both furnaces is 24 in. wide, 36 in. long, and 18 in. high. Sealed alloy radiant tubes in gas burners have a maximum input of 500,000 Btu. per hour. Both types of tempering furnaces are provided with a complete instrument panel that includes a strip chart controller, excess temperature cut-off, indicating instrument, motor starters, and switches wired to a terminal strip. Two thermocouples are also provided.

For further information circle No. 615 on literature request card, page 48-B.

Vanadium Alloy

A new self-reducing vanadium alloy has been announced by Electro Metallurgical Co. The new alloy contains an agent which reduces vanadium oxide and yields vanadium quickly and uniformly to the steel bath. It has been used to add as much as 0.80% vanadium to commercial heats of tool steel, with vanadium recoveries of 98 to 100% being reported. In the production of tool steel, self-reducing vanadium is generally added to the carbide slag during the finishing stages of a heat.

For further information circle No. 616 on literature request card, page 48-B.

Atmosphere Drier

A new gas purification line which dries atmospheres to 1 p.p.m. of moisture or other contaminants has been announced by Air-Dry Corp. of America. Automatic operation is accomplished by combining two complete systems with suitable automatic transfer controls which permit reactivation of one system while the other is in the purification cycle. Reactivation consists of removing the contaminants from the dessicant, then purging the system with clean dry gas to prepare it for the next duty cycle. Semi-automatic equipment is also available.

For further information circle No. 617 on literature request card, page 48-B.

Scale Removal

Heatbath Corp. has announced a compound for desmutting and removing heat scale from aluminum. Deoxide is used with water, 8 to 16 oz. per gal. at room temperature. Time of treatment will vary from 30 sec. to 10 min. depending upon the application. Material is furnished as a powdered product. It will not attack base metal after scale is removed.

For further information circle No. 618 on literature request card, page 48-B.

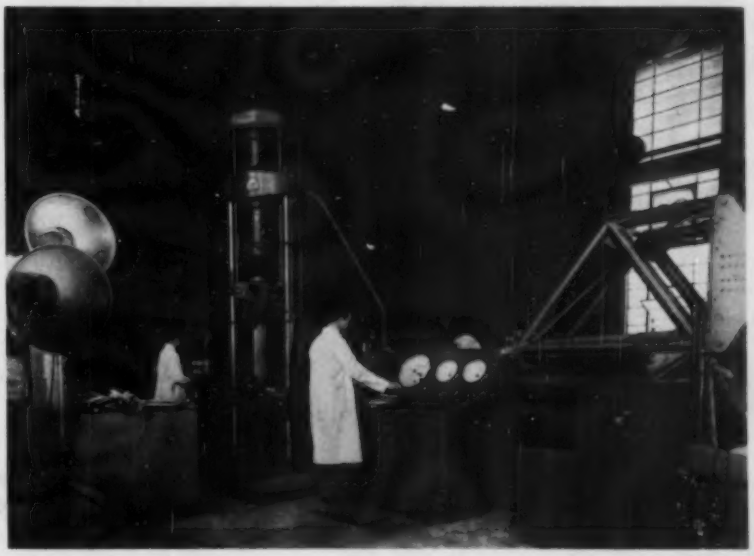
Aluminum Die Casting

The J. A. Kozma Co. has announced a new radiant aluminum die casting furnace which melts and holds the

Fatigue Testing

A universal fatigue machine capable of testing structures as well as specimens has been announced by Riehle Testing Machines Div. Large members can be tested by means of separate loading cylinders. A standard machine is capable of dynamic load applications up to 200,000 lb. and static load applications up to 400,000 lb. The machine itself is a hydraulically actuated, axial loading type machine for making both compression and tension tests. The stroke is variable from zero to the maximum capacity of the pulsator. Control console is arranged so that it is possible to measure and indicate the load developed on each cycle as a fluctuating load (high and low values) in either tension or compression and as an alternating load (maximum in compression through zero to maximum in tension).

For further information circle No. 619 on literature request card, page 48-B.



ATTENTION MR.



Are you interested in ULTRA HIGH PURITY ARGON

...in quantity...at minimum price?

Ultra High Purity Argon—we at Air Products call it U.H.P. Argon—has a purity in excess of 99.995% . . . reduces the danger of undesirable oxidation in inert gas shielded arc welding more effectively than commercial grade argon. This "research" grade gas supplied by Air Products in commercial quantities affords superior control of the weld pool and of the arc . . . less clouding and a better view.

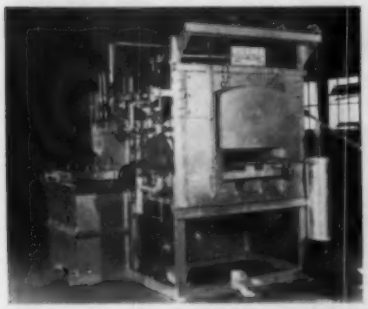
Produced by Air Products' low-temperature processing plants, U.H.P. Argon is also used as an inert protecting atmosphere in the sintering of metal powders such as titanium and zirconium . . . drawing of tungsten wire and filaments . . . fabrication of high-speed, metal-cutting tools . . . reduction of titanium and zirconium tetrachloride with magnesium.

We produce U.H.P. Argon and other industrial gases such as oxygen, nitrogen and hydrogen. We supply these gases in practically any combination of states, purities and pressures. We design, manufacture, erect and operate low-temperature processing equipment: package, tonnage and custom-built industrial gas separation, liquefaction and purification systems.

Have you a use for U.H.P. Argon . . . at competitive prices and in from cylinder to tank car quantities? Let us know if you're interested, and what your requirements may be. Air Products, Incorporated, P.O. Box 538, Allentown, Pa.

Air Products
...INCORPORATED

charge. The furnace is fired by overhead radiant cup burners which eliminate flame impingement and localized over-heating of the metal. The reduc-

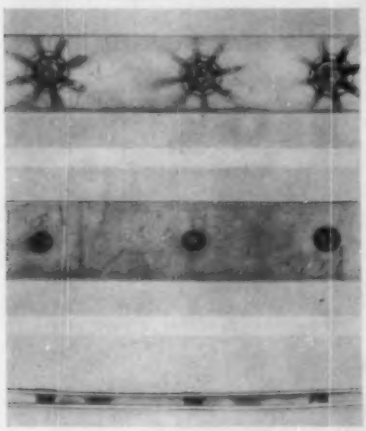


ing atmosphere in the furnace minimizes the build-up of oxides on the surface of the melt. The furnace is available with melting and holding capacities to meet most requirements.

For further information circle No. 620 on literature request card, page 48-B.

Space-Welding

A new welding method for joining spaced metal sheets with thicknesses up to ⅛-in. and gaps or spaces up to twice the thickness of the bottom sheet has been announced by Linde Co. In this new method, a delayed wire feed is used with standard Sigma spot-welding equipment and argon shielding gas so that the arc melts a hole



through the top sheet and fuses the molten material to the lower sheet. Then a column of metal is built up until it fills the hole and fuses with the top sheet. Using this method, it is possible to obtain a large fused area in the lower plate with no preparation of material to be welded other than the insertion of removable spacers between the two plates. The illustration shows top, bottom and side of two sheets of ☆ in. carbon steel which have been space welded.

For further information circle No. 621 on literature request card, page 48-B.

X-Ray Equipment

Portable, industrial X-ray equipment for radiographic inspection of castings, welds, assemblies has been announced by Mitchell Radiation Products Corp. The three units of the MS series, with K.V.P. ranges of 55 to 200, 70 to 260, 70 to 300, have built-in high tension transformers, color-coded technique charts on the face of the control panels, and protective devices for overloads, high voltage, excessive voltage and excessive oil temperature.

For further information circle No. 622 on literature request card, page 48-B.

Heat Treating Basket

Wiretex Manufacturing Co. has announced a heat treating Siamese

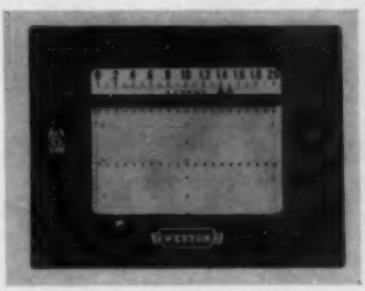


basket. The basket is made in two sections. These sections can be used together or separately. The heat treating basket is made of Type 330 stainless and each basket is 32 in. in diameter by 12 in. deep.

For further information circle No. 623 on literature request card, page 48-B.

Electric Controller

New strip chart recorders have been announced by Weston Electrical Instrument Corp. These control instruments provide all control forms including full throttling and time proportioning control, both with automatic reset and approach rate. The small case size permits mounting three of these units in the space normally occupied by two. They are available for measuring and controlling tem-



YOUR ORDER FOR 1 POUND... OR 1 CARLOAD



will be consistently uniform in dimensions and engineering properties if it's - - -

PENNROLD precision strip

Beryllium Copper
Phosphor Bronze
Nickel Silver
Brass
Chromium Copper
Stainless
(incl. 17-7 P H)
Invar
Nickel Iron Alloys

0.0005 in. to 0.040 in. thick
0.090 in. to 6 in. wide

Some immediately available. Others rolled to order in 2 to 21 days. Can be supplied in coils or straight lengths with slit or filed edges — also cadmium plated.

PENN
PRECISION PRODUCTS, INC.
501 Crescent Avenue • Reading, Pa.

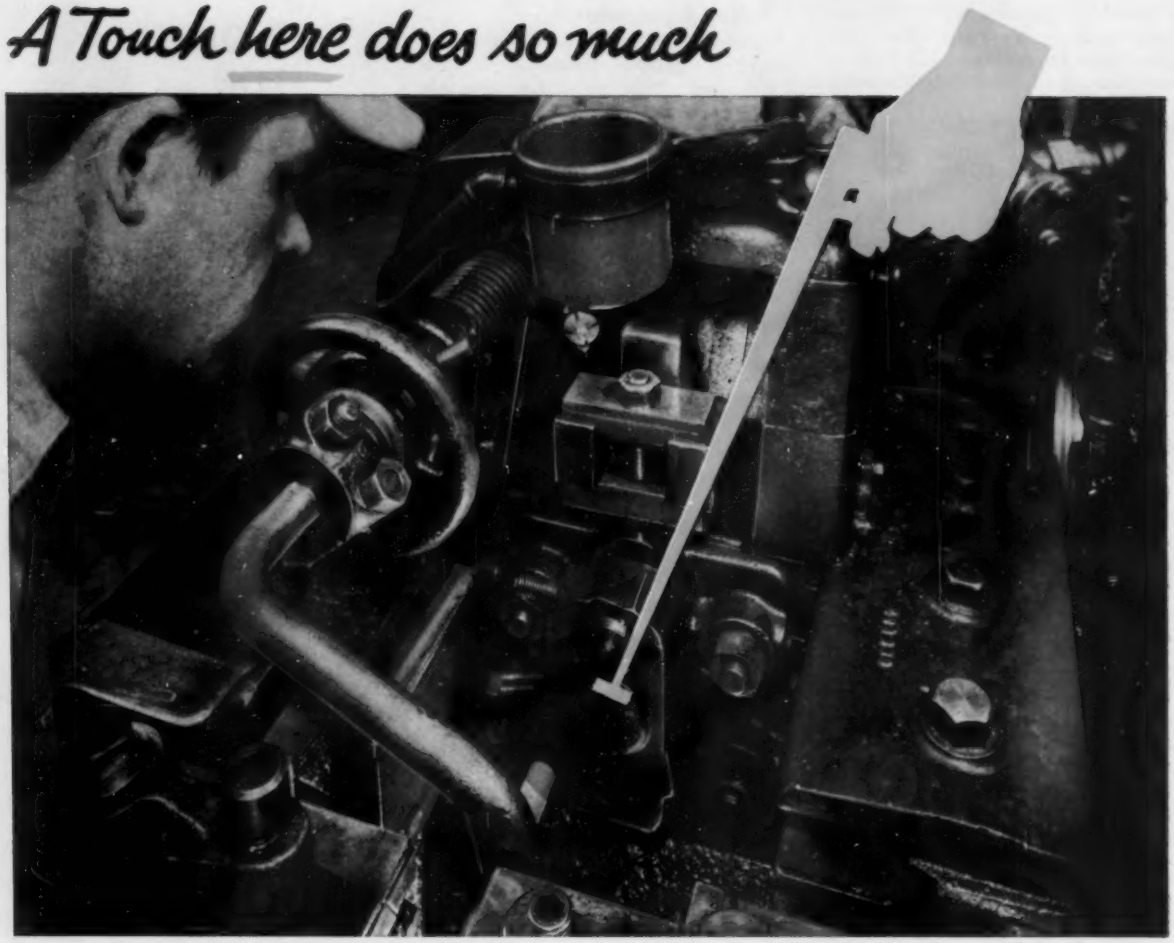
SALES OFFICES

Boston — F. G. STROKE, Wellesley 81, Mass.
Philadelphia — J. A. RHODES, Bala-Cynwyd, Pa.
Chicago — R. A. BURKETT, Franklin Park, Ill.
Houston — RANDOLPH SALES CO.
New York — H. G. WILLIAMS, Ramsey, N. J.
St. Louis — J. A. CROWE
Cleveland — L. D. ALSPACH
Los Angeles — KRUSEN WIRE & STEEL CO.

WAREHOUSES

New York — BERYLLIUM COPPER SUPPLY CO., West Paterson, New Jersey
Chicago — PENN PRECISION PRODUCTS, INC., Franklin Park, Illinois
Los Angeles — KRUSEN WIRE & STEEL CO.

A Touch here does so much



COOL PROFITS FROM HOT HEADS

A touch of 'dag'® 200 on the punch that sinks hexagonal recesses in steel screwheads increases efficiency 40%, doubles production, and improves quality. Two operations and a bulky machine are eliminated, and 42 square feet of floor space gained per machine. Life of the hex punches is extended over 500%.

Before using 'dag' 200, the die in the hammer head seized and pulled out when punched into the white hot blank, resulting in costly rejects and downtime. The unique properties of 'dag' 200, a dispersion of molybdenum disulfide, keep the hammer slamming 2,500 blanks per die — six times more than before. Three hours' downtime is saved per die, and only two-and-a-half gallons of 'dag' 200 are needed to produce 21,000 units.

This is only one of the many Acheson colloidal dispersions which keep things moving fast in hundreds of industries. Talk with your Acheson Service Engineer soon, and write for Bulletin 426, Metalworking Applications. Address Dept. MP-9.

dag®

ACHESON COLLOIDS COMPANY

Port Huron, Michigan...also Acheson Colloids Ltd., London, England

ACHESON COLLOIDAL DISPERSIONS:

Graphite · Molybdenum Disulfide · Zinc Oxide · Mica and other solids

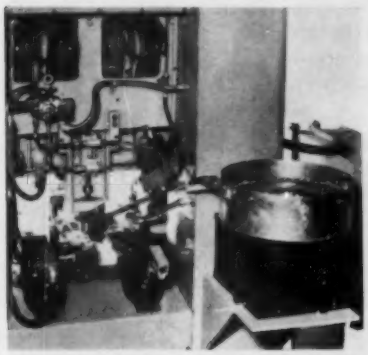
Offices in: Boston · Chicago · Cleveland · Dayton · Detroit · Los Angeles Milwaukee · Philadelphia · New York · Pittsburgh · Rochester · St. Louis · Toronto

perature, speed, millivolts, pH, conductivity and other variables.

For further information circle No. 624 on literature request card, page 48-B.

Coining Press

A new automatic coining and sizing press for metal powder parts up to 1½ in. high has been announced by Haller, Inc. Coining and sizing take place in two stages at each stroke of the press. First, the part is positioned in the die by a core pin, sizing the inside diameter. Then, the upper punch enters the die cavity and coins the part to a predetermined thickness which fills out the circumference of the cavity representing the requested outside diameter. To achieve a uniform density structure all over the length of the part, a pumpless hydraulic pressure system is provided. The press can be adapted to coin and size a variety of metal powder parts, such as complex flanged step gears, straight and flanged bushings, at a rate of nearly 1000 pieces an hour.



For further information circle No. 625 on literature request card, page 48-B.

Ultrasonic Cleaner

An ultrasonic cleaner with a self-contained filtering system has been announced by Vibro-Ceramics Div. of Gulton Industries, Inc. It operates on a frequency of 40 to 44 k.c., incorporates a forced air cooling system and has a cleaning tank capacity of 1 gal. Only sudsless detergents or chlorinated solvents are required. A circulating pump, permanent filter element and an additional tank for recirculating the fluid eliminate manually draining the tank and filtering the dirty fluid to render it reusable. The circulator automatically begins operating at the conclusion of the predetermined cleaning period.



For further information circle No. 626 on literature request card, page 48-B.

Stretcher

A 1500-ton stretcher for use on large extruded components for the aircraft industry has been announced by Lombard Corp. It has a maximum overall length of 172 ft. Its range is from 8 to 113 ft. Overall weight is 1,500,000 lb. The stretcher will receive and stretch-straighten extrusions up to 29½ in. maximum diameter.



For further information circle No. 627 on literature request card, page 48-B.

X-Ray Tube

Machlett Laboratories, Inc., has announced an end-grounded, forced-air cooled X-ray tube providing high-power continuous loading. Neither hose lines nor heat exchangers are required. The EG-180R normally requires 2 min. or less for morning warm-up time. Two versions are available—a beryllium window tube providing a 40 deg. cone of radiation and a nickel window tube providing a 360 deg. band of radiation.



For further information circle No. 628 on literature request card, page 48-B.

Vacuum Retort

A self-contained package unit for processing small parts in a vacuum or protective atmosphere has been announced by Lindberg Engineering Co. The processing is accomplished in a vacuum retort satisfactory for temperatures up to 2000° F. at a vacuum of 0.5 micron or better. The work is heat treated and cooled in the same



Best for
QUALITY CONTROL
and
RESEARCH ANALYSIS

Highest dispersion and resolution of any spectrograph!

JAco Ebert
3.4 METER CONVERTIBLE
SPECTROGRAPH

The JAco Ebert offers highest resolution and dispersion, assures unsurpassed precision and sensitivity for analyses of ordinary materials as well as super-alloys, rare earths and transuranic materials. Only the JAco Ebert embodies every desired feature for fast, reliable results plus simplicity of operation never before attained in so versatile a spectrograph. Normal peak analytical limits are easily extended through use of optional Order Sorter.

Learn more about the JAco Ebert — write today for free 8-page catalog.

Flexible: High dispersion for routine analyses . . . ultra-high dispersion and resolution for checking line interference, line shape, self-reversal; for isotopic analyses.

Simple: Easily operated by non-technical personnel.

Stigmatic: Greater reliability, versatility . . . eliminates critical adjustments.

Wide Coverage: With 28" camera, single exposure records — at high dispersion — the most sensitive lines of all metallic elements (except alkalies).

JAco **Jarrell-Ash Company**
22 Farwell Street, Newtonville, Massachusetts
San Mateo, Calif. Tinley Park, Ill. New York, N. Y.
Dallas, Texas Pittsburgh, Penna. Atlanta, Ga.

Only Gas Atmospheres Delivers completely unitized and factory tested generators . . . .

Here's an important consideration when buying generator equipment. All Gas Atmospheres Generators are unitized, compactly constructed and assembled by experts on a common frame and thoroughly factory tested to specification. When they reach their destination they are ready to set into position and go to work with an absolute minimum of make ready.

This practice assures you that you get exactly what you ordered and permits Gas Atmospheres engineers to build more generator into a smaller frame. What's more, unitization greatly simplifies maintenance — reduces downtime and upkeep costs.

Why not look into the many advanced features found only in Gas Atmospheres generators when next you're in the market? Let us put you in touch with a user and we're sure your next generator will be a Gas Atmospheres.



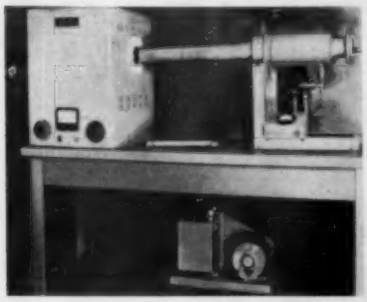
The second of two 20,000 cfh food purity nitrogen generator systems, includes generator through purification — drying and compressing to 250 lbs. on a common base.

gas Atmospheres, inc

equipment for producing industrial gases

20011 WEST LAKE ROAD CLEVELAND 16, OHIO

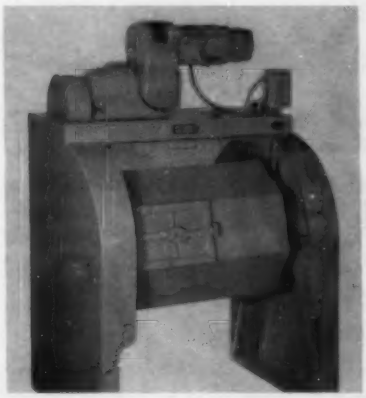
tube. The complete package consists of a furnace, automatic controller, pyrometer, 3 in. i.d. tube with water jacketed cooling chamber, track and



accessories for inserting tube into heat zone, 7 in. work boat, mechanical vacuum pump, diffusion pump and vacuum gage, all on a steel work table.
For further information circle No. 629 on literature request card, page 48-B.

Barrel Finishing

New barrel finishing equipment, designed for small to medium large production runs, has been announced by



the Casalbi Co. It will do up to four operations at one time, or process up to four large precision parts at one time, in individual compartments. Barrel capacity is 8.2 cu. ft.
For further information circle No. 630 on literature request card, page 48-B.

Indicator

A new, self-balancing indicator with built-in key or push-button switches has been announced by Thermo Electric Co. It is available for thermocouples, with a null balance potentiometer measuring circuit and automatic cold-junction compensation, or for resistance bulbs, with a null balance a.c. bridge measuring circuit. This indicator will check many temperatures from remote or nearby points. Key switches accommodate up to 48 points for thermocouples and 36 for resistance bulbs while push-buttons accommodate up to 24 points for either. There are 30 available scale ranges covering —400 to +3000° F. for all standard thermocouple calibrations and —100 to +600° F. for resistance bulbs.
For further information circle No. 631 on literature request card, page 48-B.

Hardfacing

New tubular wire electrodes for open-arc, semi-automatic welding have been announced by the American Manganese Steel Div. The electrodes are 3/32 in. in diameter. Flux and hard-



facing alloy, proportioned for the proper weld deposit, are held within the drawn steel tube. Two types of tube wire are offered: S/A manganese wire coils, for manganese steel build-up and repair applications, and S/A 53 for hardfacing to resist both wear and impact. The prelubricated wire travels through 14 ft. of flexible cable to the nozzle end. The steel outer shell of the tube wire has been work-hardened, affording a better grip for pressure and feed rolls. The new tubular electrodes are designed for use with Amsco's MF semi-automatic welder.
For further information circle No. 632 on literature request card, page 48-B.

Scale Prevention

A compound for preventing oxide scale formation on ferrous parts during stress relieving operations has been announced by G. W. Smith & Sons. Protect-O-Metal No. 2 is thinned with water and painted or sprayed on the part to be stress relieved. The part is placed in the furnace for normal heat treating. After cooling, the compound is removed with a wet or dry rag or a brush, leaving the part free of scale for painting or other after treatment. The compound has been used at temperatures to 1500° F., for any length heating cycle.
For further information circle No. 633 on literature request card, page 48-B.

Die Machining

The Elox Corp. has announced Die-Matic machines for machining forge,

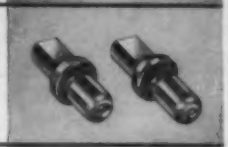
Call on CLARK

for All Your "Rockwell Testing" Needs

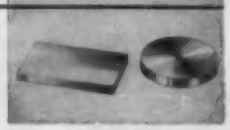
CLARK Diamond Cone Penetrators are exactly right for your "Rockwell" hardness tester, whether or not it bears the CLARK name. Every step in their manufacture, from careful diamond selection to expert lapping, leads to a precision product that will give you precision results. Yet CLARK Diamond Penetrators cost surprisingly little.



CLARK Steel Ball Penetrators, for accurate "Rockwell testing" of unhardened steel, cast iron, brass, bronze, and similar materials, are available in all standard sizes.



CLARK Test Blocks, in various hardness grades, provide a quick, sure, and simple method of checking the accuracy of your "Rockwell" type hardness tester.



Write today for descriptions and prices.

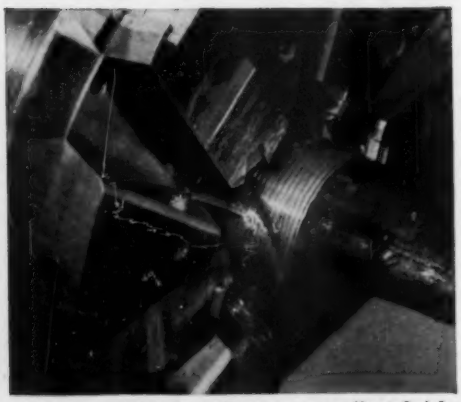
CLARK INSTRUMENT, INC.
10202 Ford Road • Dearborn, Mich., U.S.A.

CLARK



For precision cutting...

TRANSPARENT SUNICUT OILS ASSURE YOU GOOD VISIBILITY, PEAK PRODUCTION



Transparent Sunicut oils assure excellent finish in critical operations at close tolerances. Good visibility speeds production.

Transparent Sunicut® oils, including heavy-duty and dual-purpose oils, are available in many grades to suit your specific needs. They give outstanding results...especially where precision cutting is required.

Their transparency takes the "blinders" from work that needs close watching, permitting close product control, faster production, lower unit cost. Machine operators like Sunicut's "cleanliness." Most important, *transparent Sunicut oils assure you of good finishes.*

For full information about Sunicut cutting oils, call your Sun representative, or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. MP-9.

INDUSTRIAL PRODUCTS DEPARTMENT

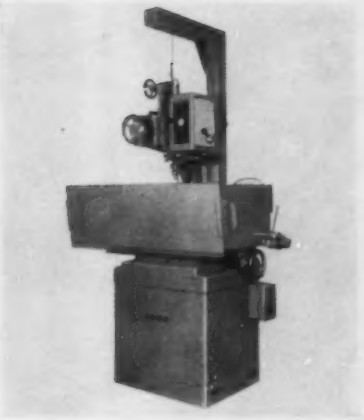
SUN OIL COMPANY

Philadelphia 3, Pa.

In Canada: Sun Oil Company Limited, Toronto and Montreal

SUNOCO®

©Sun Oil Company

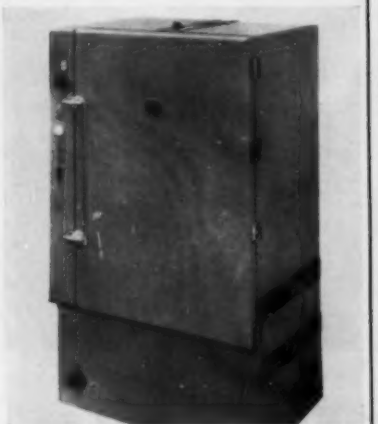


die cast, blanking, extrusion, embossing dies. The M-501 machines any metal regardless of hardness or density. It is also used to machine soft steels and nonferrous metals such as magnesium and aluminum. Machining is done by electrical energy, not mechanical energy, thereby eliminating any force on the tool. The DieMatic has longitudinal travel on the table, cross-slide travel on the over-arm, and vertical adjustment on the cross-slide assembly for easy adjustment of electrode to workpiece.

For further information circle No. 634 on literature request card, page 48-B.

High-Temperature Ovens

The American Instrument Co. has announced new ovens for operation at 110 to 750° F. Oven temperatures are controlled by an Aminco bi-metal thermoregulator. The largest of the new



line of high-temperature ovens offers a 17 cu.ft. work chamber. Ovens feature horizontal air-flow, an air-distribution system assuring minimum thermal gradient, control dampers to permit choice of recirculated or non-recirculated air, and front-panel controls.

For further information circle No. 635 on literature request card, page 48-B.

Tension Monitor

A yield tension monitor which will electronically test and control the metal for uniform strength as missile parts are formed on the radial draw former has been announced by Cyril Bath Co. A load cell operates between the face of the ram and the gripper head which holds the work piece. The recorded measurement is the difference in resistance between the strain gage circuit and the constant dummy load. This result is fed into the strain gage amplifier and then is passed through a bridging network to a power amplifier

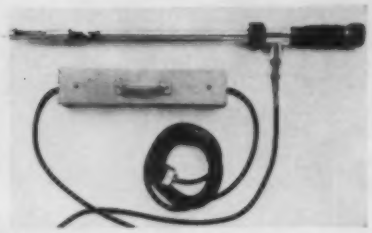


which signals a servo motor to control the oil relief valve. It is this control of oil flow which provides tension control to the radial draw former.

For further information circle No. 636 on literature request card, page 48-B.

Inspection

A new borescope announced by Lenox Instrument Co. permits internal inspection of tanks, vessels, combus-



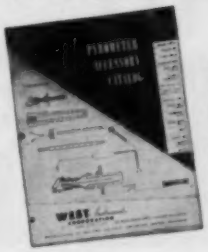
tion chambers and other equipment by means of an adjustable mirror, which can be controlled by a hand-wheel to permit scanning from retrospective through right angle to forward oblique. This borescope gives a magnification of 10×, a field of vision 9 in. in diameter at a distance of 24 in., and has a viewing head with a 100 watt lamp for illumination.

For further information circle No. 637 on literature request card, page 48-B.

Cleaning Machines

A new washer for removing oil from work before and after heat-treating or for general utility cleaning operations has been announced by Eclipse Fuel Engineering Co. It may be used either in an integrated, continuous line or as an individual unit serving a number of heat-treating furnaces. The new washer uses either hot caustic or detergent and has a work area 24 by 36 by 18 in. Two

THERMOCOUPLES
for every industry



DATA BOOK
New 32-page file book

★ Handily lists all data (I.S.A.) and
★ Graphically shows easiest way to select precisely the best thermocouple and protective tube for each operation.
★ Lists all components, with prices and
★ Provides handy reference for stock record.

STANDARD AND SPECIAL

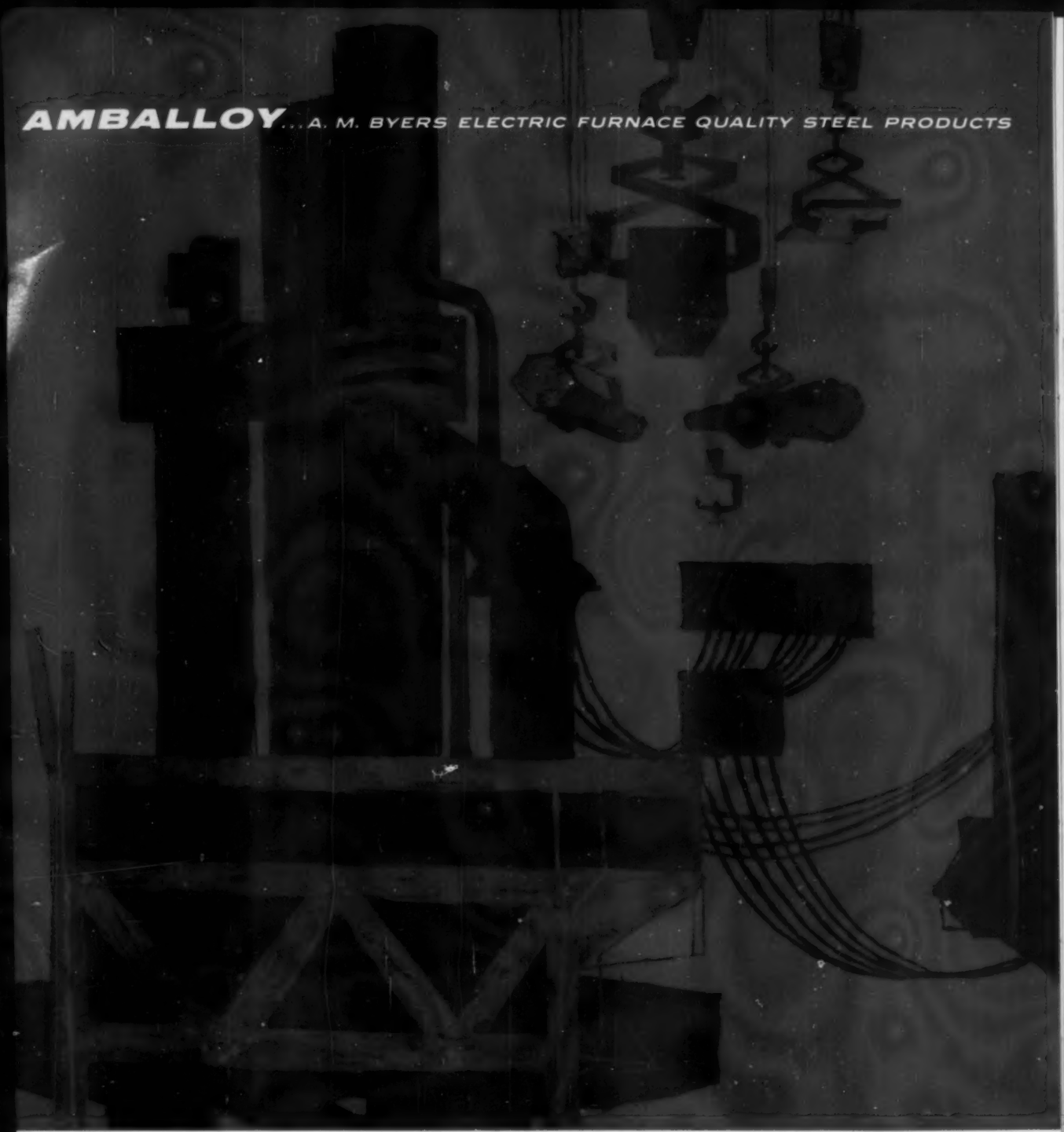
For furnaces, ovens, kilns, moulding machines, pipelines, freezers, etc.

For use with all standard types of temperature indicators, controllers, recorders.

We make thermocouples from matched and checked wires to insure constant millivolt output for accurate readings. Complete selection.

FREE *write for your copy Now...*

WEST Instrument CORPORATION
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES



TIMETABLED DELIVERY... SERVICED BY SPECIALISTS

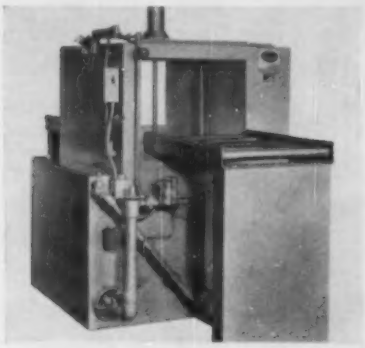
Quality carbon, alloy and stainless steels with the best service in the industry are our guarantee to each customer. We start with a quality product—AMBALLOY steels—then follow up with a firm delivery date that gets your order where you want it, when you want it, fast.

But the Byers service policy extends beyond delivery. High grade conversion facilities are an important part of our program. We also offer a personalized technical service through our highly-trained corps of metallurgists.

Ninety-three years of producing ferrous metals have familiarized us with many of your problems. So check Byers first for your steel requirements. Write for new catalog. A. M. BYERS COMPANY, Clark Building, Pittsburgh 22, Pennsylvania.

A growth company with the emphasis on quality and service **A. M. BYERS COMPANY**

basic models are available: double-end design that is loaded at the front and unloaded at the back, and in-and-out type unit that is loaded and unloaded through the same opening. The hooded solution tank has a capacity of 300 gal. A pneumatically operated work rack is used to lower work into the



solution tank. Jet-type air agitation is provided for the automatic washing operation.

For further information circle No. 638 on literature request card, page 48-B.

Electroplating

Enthone, Inc., has announced the first two of a series of new preparation processes for electroplating. The Enbond "Z" process, for the treatment of zinc base diecastings, uses anodic electrocleaner and a companion acidic activator to produce a surface ready for standard copper plating operation. The second process, called the Enbond "BR" process, is intended for preparation of brass and other copper alloys for any type of electrodeposit. The cleaner and the activator for both processes are powdered products.

For further information circle No. 639 on literature request card, page 48-B.

Ionization Gage

A new ionization vacuum gage which gives continuous pressure readings on eight linear ranges from 1 x 10^{-4} to 2 x 10^{-12} mm. Hg has been announced by the Rochester Div. of Consolidated Electrodynamics Corp. This instrument has been designed to control, read and degas any type of commercially available ionization tube. The emission control is variable over a continuous linear range from 25 microamperes to 20 milliamperes, and is regulated throughout the range to ±2%. An accessory two-station thermocouple circuit is available with a range from 1 to 1000 micron Hg. Pressure for either of the two stations can be read directly in microns Hg on a special scale of the same meter used

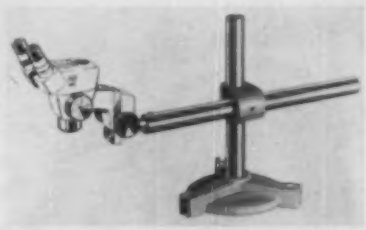


for the ionization gage reading. The GIC-100 is 8¾ by 17¾ by 13½ in. and weighs 45 lb.

For further information circle No. 640 on literature request card, page 48-B.

Microscope Stand

A new table stand for horizontal and vertical positioning of the Cyclop-



tic stereoscopic microscope has been announced by the American Optical Co. It has a wide range of adjust-

cleaned and back at work in 5 minutes



Waukee FLO-METER

The Waukee FLO-METER can be cleaned and back in operation in five minutes *or less!* Saves time and money.

Inherent accuracy of the FLO-METER is protected by Waukee's design for fast, easy cleaning. No tools are needed. Production interruption at a minimum.

The Waukee FLO-METER also features: built-in Control Valves, panel mounting, simple piping, large 6" and 9" scales for ease of reading. Capacities 3 CFH to 10,000 CFH.

Complete information in Bulletin 203. Write for it. **Waukee Engineering Company,** 5140 North 35th Street, Milwaukee 9, Wisconsin.

For measuring: air — ammonia — dissociated ammonia — argon — butane — city gas — endothermic cracked — exothermic cracked — forming gas — helium — hydrogen — natural gas — nitrogen — oxygen — propane.

Waukee FLO-METERS • AIR-GAS MIXORS INDUSTRIAL WASHING MACHINES



make hardness tests ANYWHERE WITH THE NEWAGE TESTER

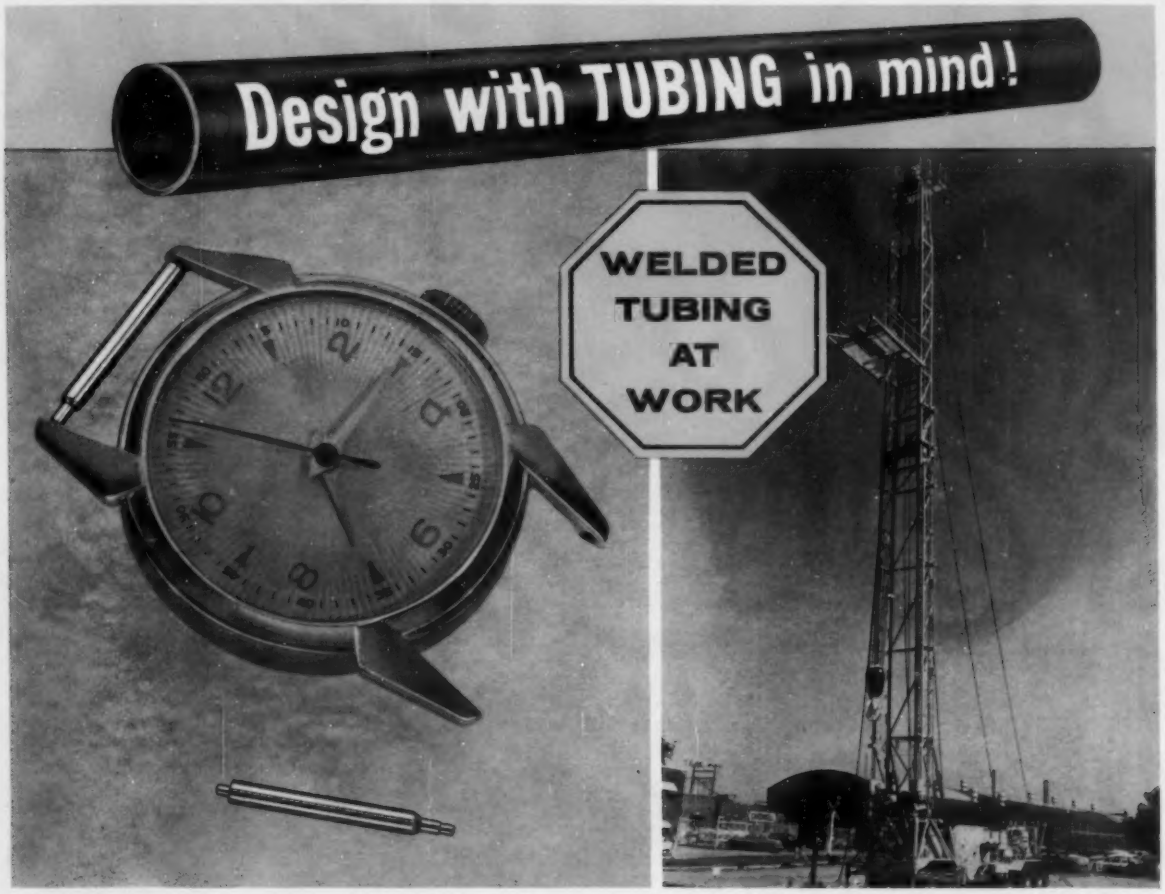
- CLAMPS, JAWS & BASE PLATE ARE ELIMINATED
- NO CONVERSIONS OR CALCULATIONS
- TEST ANY SIZE, SHAPE OR TYPE METAL
- NO SKILL REQUIRED
- SCALE READINGS IN ROCKWELL & BRINELL
- ACCURACY GUARANTEED

Many thousands used by industry and government. Write, wire or call for additional details and prices.

NEWAGE INDUSTRIES, INC.

222 York Road *Jenkintown, Pennsylvania*
TUrner 4-8494 *Dept. MP*

Design with TUBING in mind!



Accuracy suitable for telescoping, strength for a vital service, corrosion-resistance to withstand body acids—all recommend Welded Stainless Steel Tubing for this tiny watch pin.

Great structural strength, lightweight for mobility, uniformity for inter-working parts—all recommend Welded Carbon Steel Tubing for this oil country drilling rig.

For maximum strength • minimum weight

CHOOSE WELDED TUBING IN ANY SIZE

Carbon • Alloy • Stainless Steel

The tubular form is one of engineering's most efficient sections—and Welded Tubing with greater uniformity about its axes is tubing at its best. Whether you have design requirements for great strength, light weight, high RPM, interchangeability of components, heat, pressure or corrosion—there is a size and grade of Welded Tubing to do your job best. For all tubing applications, consult a quality tubing producer.

An Association of Quality Tube Producers

FORMED STEEL TUBE INSTITUTE



Design inspiration for you

The 260-page Handbook of Welded Steel Tubing contains inspiration and data for tubing designs. For your copy, write on your company letterhead, giving your title.

FORMED STEEL TUBE INSTITUTE
850 HANNA BUILDING • CLEVELAND, OHIO

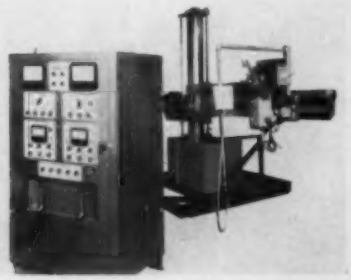


ments—a full 360 deg. swing around a vertical pillar over a 4 ft. circle and a 20 in. horizontal and a 15 in. vertical excursion. The heavy-weight base is notched to allow quick attachment to work table when a relatively permanent set-up is required.

For further information circle No. 641 on literature request card, page 48-B.

Welding Control

The Weltronic Co. has announced a new tungsten inert-gas fusion welder control. The console contains the arc



power supply, automatic arc length control, wire drive, carriage drive, gas and water controls, and timer sequence. Flexibility in sequencing, a choice of starting, intermediate and finishing settings for the current, for the carriage speed and for the wire speed, and stepless electronic control of the arc from 10 to 400 amp. are offered. The Weltronarc control can be used with an automatic seam and circumferential welder, automatic arc spot welder, and for manual welding.

For further information circle No. 642 on literature request card, page 48-B.

Nickel Stripper

United Chemical Corp. has announced a new nickel stripper which contains no cyanide, caustic or acid. The product is marketed in two solutions which can be mixed and diluted to proper strength. The bath is operated at 70 to 175° F. at a pH of 7 to 11. One gallon of Ni-Plex bath will strip 43¼ sq. ft. of 0.0001 in. nickel plate. The stripping rate at room temperature is 0.00025 in. per hour; at 175° F. the rate is 0.0015 in. per hour.

For further information circle No. 643 on literature request card, page 48-B.

Testing Machines

A new line of low capacity testing machines has been announced by the Tinius Olsen Testing Machine Co. Available in standard capacities of 100 to 5000 lb. these electro-mechanical machines feature electronic load

For the best, buy
DETROIT
Testing Machines

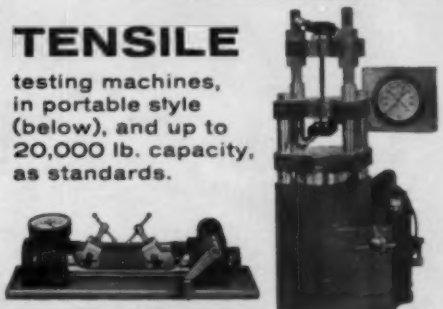


BRINELL
hardness testing machines in many standard models. Special models too.



DUCTILITY
testers for sheet metal are hydraulically powered, have 3/16-inch capacity.

TENSILE
testing machines, in portable style (below), and up to 20,000 lb. capacity, as standards.



Write today for more information

DETROIT TESTING MACHINE COMPANY
9384 Grinnell Avenue, Detroit 13, Michigan

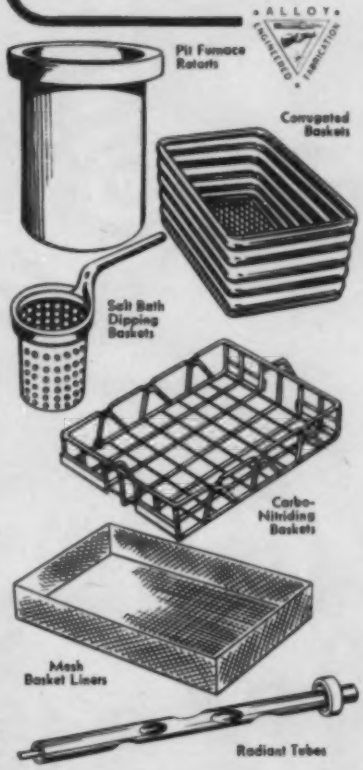
NOW Available...

MISCO Heat-Treating Tools from Stock!

MISCO heat-treat process equipment is engineered and fabricated by qualified specialists in the field of heat-resisting alloy materials.

With a wide variety of job-proven heat-resisting steel products available for immediate delivery, Misco Fabricators provide a real service to heat-treaters, who no longer need carry an expensive inventory of equipment.

Remember, whatever your need, Misco Fabricators offer sound, economical designs in the best metal for your purpose. It pays to do business with Misco Fabricators—Specialists in Nickel-Bearing Alloy Fabrication.

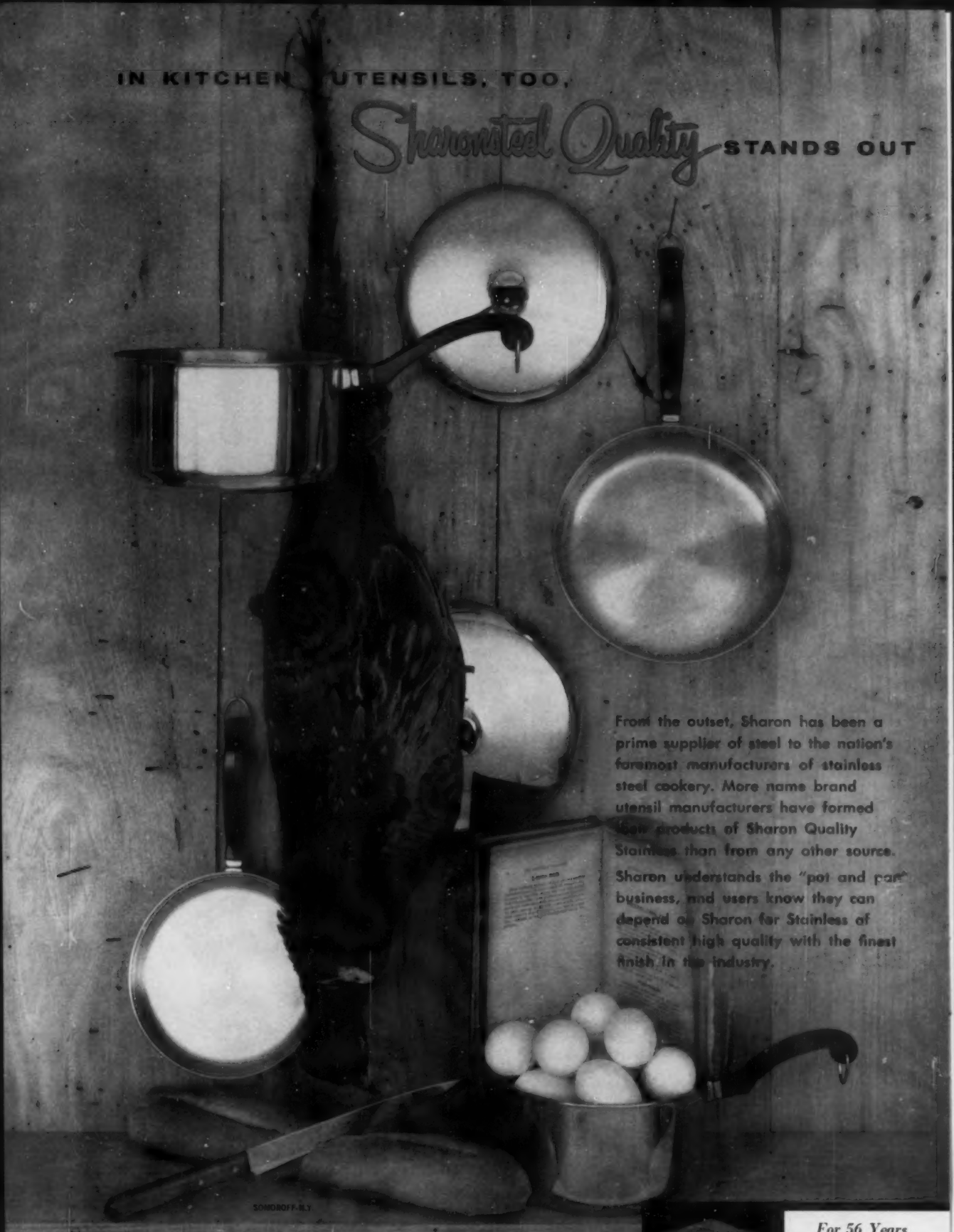


Special Equipment Designed and Made to Order

MISCO FABRICATORS, INC.
Designers, Builders, Fabricators of Heat-Resisting Alloy and Stainless Steel Equipment
2420 WILLS AVENUE • MARYSVILLE, MICHIGAN
TELEPHONE YUKON 5-6191

IN KITCHEN UTENSILS, TOO,

Sharonsteel Quality STANDS OUT



From the outset, Sharon has been a prime supplier of steel to the nation's foremost manufacturers of stainless steel cookery. More name brand utensil manufacturers have formed their products of Sharon Quality Stainless than from any other source.

Sharon understands the "pot and pan" business, and users know they can depend on Sharon for Stainless of consistent high quality with the finest finish in the industry.

SOMOROFF-NY

SHARONSTEEL

For 56 Years a Quality Name in Steel

CHICAGO, CINCINNATI, CLEVELAND, DAYTON, DETROIT, GRAND RAPIDS, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, NEW YORK, PHILADELPHIA, ROCHESTER, SAN FRANCISCO, SHARON, SEATTLE, MONTREAL, TORONTO

SHARON STEEL CORPORATION, SHARON, PENNA.

indication. Each machine has two range capacities—full and 1/5 or 1/4 capacity indicated on the same dial. Range may be changed at will during

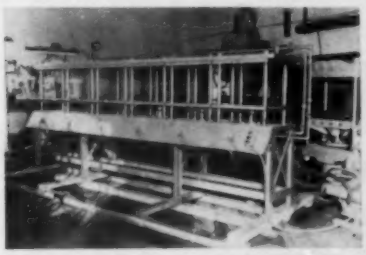


test. Variable testing speeds of from 0.3 to 12 in. per minute are electronically controlled and are positive under load or no load.

For further information circle No. 644 on literature request card, page 48-B.

Straightening

Six-station hydraulic presses for straightening or flattening automatic transmission parts warped in heat treatment have been announced by Wabash Metal Products Co. The parts are placed in the press in stacks, a



stack in each station. After station number six is loaded, station one is ready to unload. Gas heated platens apply heat to parts to be straightened at the same time that pressure is applied.

For further information circle No. 645 on literature request card, page 48-B.

Control of Test Limits

A new device that is used to turn on and off test apparatus, limits of which are sensed by strain gages, thermo-



couples or any other transducers that have a maximum output not exceeding 100 millivolts d.c., has been announced by Spar Engineering & Development. The programmer counter is a millivolt electronic relay having adjustable energizing and release thresholds and DPDT 15 amp. contacts. Its two adjustable thresholds provide for selection of upper and lower operating limits and a counter registers each cycle. The instrument operates on 110 volts a.c.

For further information circle No. 646 on literature request card, page 48-B.

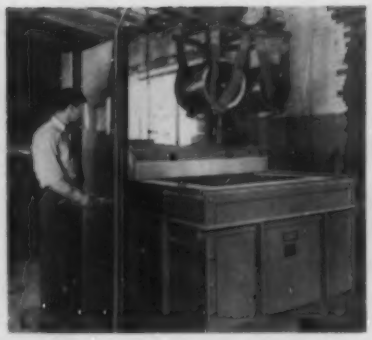
Protective Covering

Onco Products, Inc., announced a protective covering for fine metal finishes. Developed to protect stainless steel finishes for curtain wall use, it will withstand 120 hr. in a Weatherometer at 140° F., exposure to rain, sleet, sand and smoke, in-planting handling, shipping and outdoor storage hazards. Onco is easy to apply and easy to strip.

For further information circle No. 647 on literature request card, page 48-B.

Salt Bath Annealing

An electric self-circulating salt bath annealing furnace for wire has been announced by Ajax Electric Co. Cir-



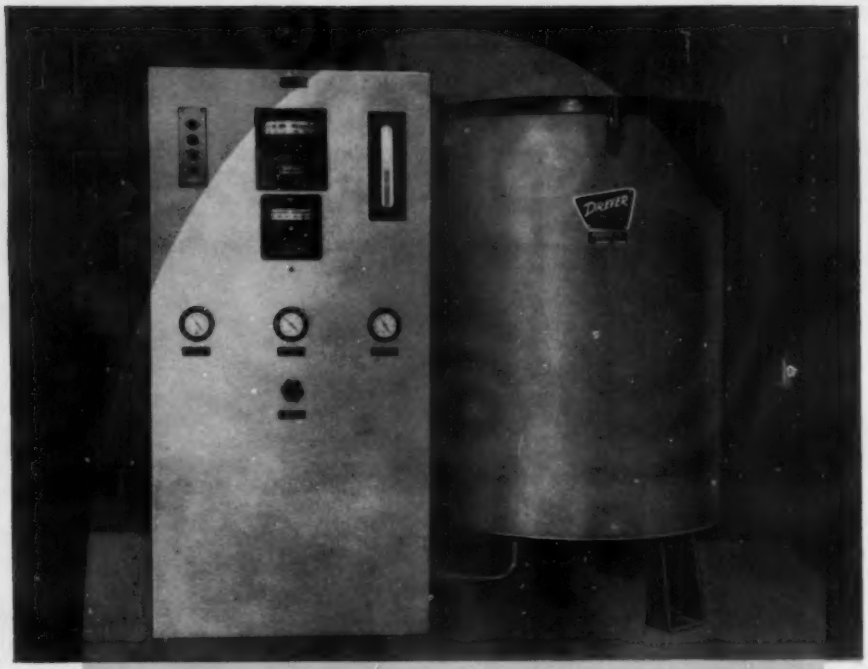
culation is provided by patented closely-spaced electrodes. The stirring action assures a uniform temperature throughout the bath and annealed wire has no hard or soft spots.

For further information circle No. 648 on literature request card, page 48-B.

Spot Welding

Air Reduction has announced the availability of a spot kit that converts standard Model 21 manual Aircomatic welding guns for arc welding. The kit consists of an auxiliary control panel, an outer barrel and a flat nozzle. Spot welding of lap joints, or tack welds in a butt, lap or fillet joint can be made on mild and stainless steels. Welds are produced by placing the gun against the work and operating the





"Cracked" Ammonia shows tremendous cost saving and unsurpassed performance

1. —Bright Annealing—Stainless Steels, Nickel and Nickel Alloys, Beryllium Copper, Silicon Copper Alloys and Bronzes, and high and low carbon steels.
2. —Clean Hardening—High carbon and high chrome tool steels.
3. —Copper Brazing of all types of ferrous metals.
4. —Sintering of Powdered Metal Parts.
5. —Bright Annealing of Electrical Steels.
6. —Reduction of Metal Oxides.
7. —Atomic Hydrogen Welding.
8. —Radio Tube Sealing.

the Drever Ammonia Dissociator

produces the ideal protective furnace atmosphere

We can supply COMPLETE STORAGE SYSTEMS for tank car lots of anhydrous ammonia. This reduces the cost of ammonia approximately 75%. *Write for bulletin B-52*

DREVER COMPANY

RED LION ROAD & PHILMONT AVE., BETHAYRES, PA.

20-C



trigger. The heat of the gas-shielded arc between the work and the automatically fed filler wire produces a circular weld. The required amount of filler wire is melted off, being added to the weld for reinforcement.

For further information circle No. 649 on literature request card, page 48-B.

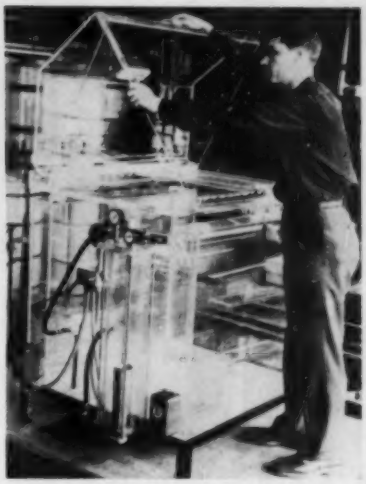
Carbon-Sulphur Analysis

A new combustion boat for use in carbon and sulphur analysis has been announced by the Harry W. Dietert Co. The new boat is light in color and is 3¾ by ½ by 7/8 in. in size.

For further information circle No. 650 on literature request card, page 48-B.

Corrosion Test Cabinet

A redesigned transparent test cabinet has been announced by the G. S. Equipment Co. The transparent water jackets which house the two electric heaters, front and back, are extended to the full width of the cabinet. The cabinet holds to temperature ±0.5°



F. Extra insulation effect prevents excessive fogging or condensate on transparent walls.

For further information circle No. 651 on literature request card, page 48-B.

HOW INDUSTRY USES
INVESTMENT CASTING TO GET

5 parts for the price of 1

By reducing 22 separate set-ups and more than 30 different machine operations to 5 machine operations after INVESTMENT CASTING, the cost of producing these control cylinder housings was cut to the point that now five cylinder assemblies are produced at the original cost of one*.

The advantages of Investment Casting are many. It can save money in production costs. It can make possible the use of harder alloys for longer machine life. And it can simplify many design problems now considered impractical.

Get the full story of Investment Casting today. You may find in it the solution to some of your production or design problems.



*Details on request.

Send for our latest 12-page booklet, "Modern Precision Investment Casting." It gives you full details of the "how and why" of Investment Casting.



ALEXANDER SAUNDERS & CO.

Precision Casting Equipment and Supplies
93 Bedford Street, New York 14, N. Y.
WAtkins 4-8850

Photo and data courtesy of Precision Metalsmiths, Inc.

MEASURE TEMPERATURES ACCURATELY FAST with



PYRO
OPTICAL PYROMETER

Instantly measures temperatures of minute spots, fast moving objects, smallest streams. Stock ranges from 1400° F to 7500° F.

Send for free catalog No. 85.

and

PYRO
SURFACE PYROMETER

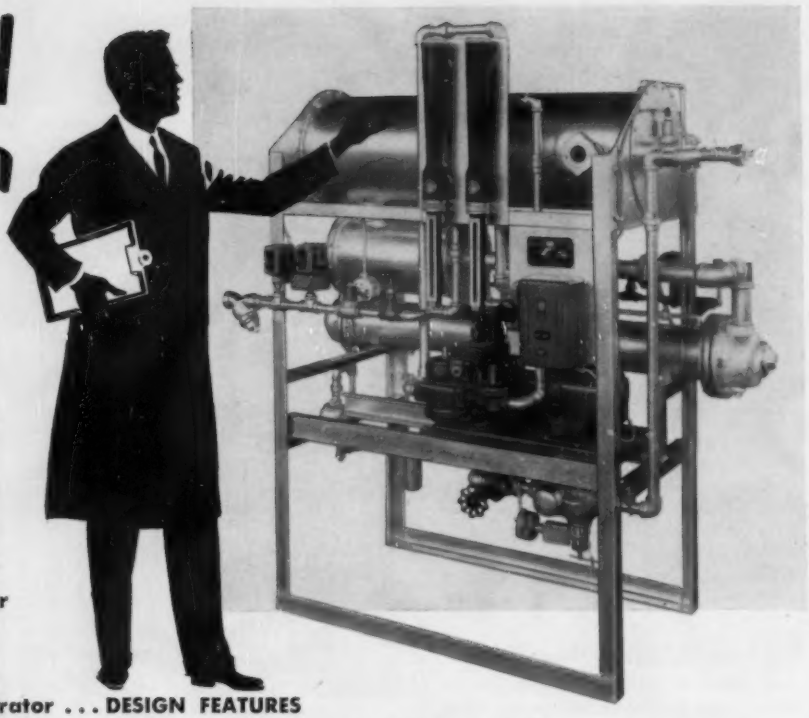


Quick-acting, precise, with easy-to-read 4¾" dial. Five standard ranges — 0° to 300° F to 0° to 1200° F for surface and sub-surface temperatures. All sub-zero and special ranges.

Send for free catalog No. 168.

PYROMETER INSTRUMENT CO. INC.
BERGENFIELD 8, NEW JERSEY

For added protection



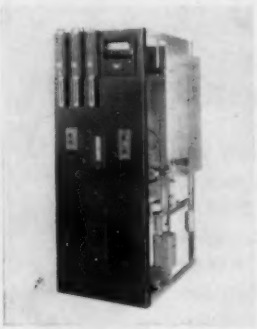
CHOOSE HAYES PROTECTIVE ATMOSPHERES!

Proper atmosphere equipment increases production, improves product quality, and makes your processing more economical!!

HAYES Type G Exothermic Generator . . . DESIGN FEATURES

For conveyor or pusher type furnaces requiring protective atmospheres of an oxidizing or medium reducing type, the Hayes Type G Exothermic Generator offers many design advantages which include:

- **ELECTRIC IGNITION SYSTEM** for added safety! Simple, effective design, stainless steel construction. Located out of actual combustion chamber to prevent burn out.
- **AUTOMATIC COMBUSTION CONTROL** is obtained by a self-adjusting mixing device which maintains the pre-set combustion ratio thereby eliminating the need for manual regulation of the gas-air valves.
- **HEAT EXCHANGER** designed with easily accessible, straight tubes . . . facilitates cleaning without disassembly.
- **FLOW METERS** give accurate indication of actual, not relative, flow measurement.
- **SPECIAL FEATURE AVAILABLE** to adapt standard model to glass-to-metal sealing applications. Request details.
- **STANDARD SIZES** range from 200 CFH to 4000 CFH. Larger sizes also available.



Hayes Type IGL Endothermic Generator incorporates many of the above design features . . . is ideal for providing protective atmospheres which are not only reducing but are adjustable for carbon potential . . . giving protection to medium or high carbon steel. Provides for the close control of retort temperatures, complete control of gas and air ratio and subsequent atmosphere dew point. Request complete data!

Hayes Type AD Ammonia Dissociators are now available at rated capacities up to 5000 CFH . . . producing a comparatively inexpensive hydrogen-nitrogen atmosphere of extreme purity and very low dew point. Such atmospheres are required for heat treatment of stainless steels and are extremely helpful in providing protection where exothermic atmospheres are not adequate.



Hayes Molecu-Dryer, a new concept in air and gas drying, effectively removes moisture down to a dew point of —100°F. Request complete data.

Hayes Service Engineers assist customers in starting their equipment and adjusting it to meet their exact requirements. Whatever your heat treating problem, bring it to the unique Hayes Laboratory for recommendations!!

ELECTRIC CERTAIN CURTAIN FURNACES

C. I. HAYES, INC.

Established 1905

802 WELLINGTON AVE. • CRANSTON 10, R. I.

Request Bulletin 256 for complete information on Hayes Atmosphere Equipment. Let us show you how to improve your product, increase output, and reduce unit costs . . . with RESULTS GUARANTEED! Check literature desired on any of the following procedures . . . write today!

- ☐ Vacuum Heat Treating
- ☐ High Speed Hardening
- ☐ Tool Steel Hardening
- ☐ Carbo-Nitriding
- ☐ Tempering
- ☐ Bright Heat Treating
- ☐ Stainless Steel Heat Treating
- ☐ Sintering
- ☐ Copper Brazing and Soldering
- ☐ Lead Pot Hardening and Tempering

Name_____

Company_____

Street_____

City and State_____

APPLICATION and EQUIPMENT new literature

653. Abrasive Cleaning
Catalog 57-WX on brush types, sizes, speeds, filaments. Aids to power brush selection. *Pittsburgh Plate Glass, Brush Div.*

654. Air Washers
Bulletin No. 256 on acid-proof air washers for ventilation systems. Construction and accessories. *Automotive Rubber Co.*

655. Alloy Chart
Comparison of AISI, SAE, ACI, AMS, WAD and PWA chromium and chromium-nickel stainless specifications. *Cannon-Muskegon*

656. Alloy Steel
40-page book on applications of heat treated, special alloy steel. *Jones & Laughlin*

657. Alloy Steel
32-page book on abrasion resisting steel. Properties, fabricating characteristics, uses. *U.S. Steel*

658. Aluminum Die Castings
Bulletin on design and manufacture of aluminum die castings. *Hoover Co.*

659. Ammonia Dissociator
12-page bulletin B-53 on ammonia dissociation equipment. Sizes and capacities, testing unit, cost chart. *Drever Co.*

660. Atmosphere Furnace
Information on mechanized batch-type atmosphere furnaces for gas cyaniding, gas carburizing, clean hardening or carbon restoration. *Dow Furnace.*

661. Austempering
Bulletin No. 167 on mechanized salt bath installation for continuous heat treatment of farm tools. *Ajax Electric*

662. Barrel Finishing
12-page booklet gives case histories, materials for barrel finishing, equipment. *Minnesota Mining & Mfg. Co.*

663. Batch-Type Furnaces
Bulletin SC-174 on furnaces in the operating range of 1400 to 1750° F. for various heat treating processes. Suction radiant tube fired units and mechanized systems. *Surface Combustion*

664. Beryllium Copper
12-page Bulletin 6 on advantages of beryllium copper and suggestions for ordering, including alloys, condition and temper, tolerances. *Penn Precision Products*

665. Blackening
4-page bulletin on process of blackening parts by heat and chemicals. A typical installation is portrayed. *E. F. Houghton*

666. Black Oxide Coatings
8-page booklet on black oxide coatings for steel, stainless steel and copper alloys. *Du-Lite*

667. Blast Cleaning
Complete information on Malleabrasive for cleaning and finishing. *Globe Steel Abrasive*

668. Bonding Mortar
Data sheets on cold-setting, high-temperature bonding mortar, chromium-base, cold-setting mortar, and silica cement. Where and how to use them. *Harbison-Walker Refractories*

669. Boron Additive
6-page article on use of grainal as boron additive alloy and properties of grainal steels. *Vanadium Corp.*

670. Brazing
8-page reprint on production brazing illustrates items produced and how they are made. *Selas Corp.*

671. Brazing
28-page catalog of brazing and soldering equipment with suggestions on setting up brazing lines to fit the product being joined. *C. M. Kemp*

672. Brazing
20-page reprint GER-106 on electric furnace brazing tells how it is used with pressed metal parts, to simplify product design and for assembly. *General Electric*

673. Brazing Aluminum
12-page bulletin, ADR 45, on how to torch braze aluminum and strength of joints so brazed. *Air Reduction Sales*

674. Carbon Control
16-page bulletin on equipment for carbon and sulphur determination, including combustion furnaces and other accessories. *Harry W. Dietert*

675. Carbonitriding
28-page booklet on nature of process, furnaces, atmospheres, parts carbonitrided and properties. *Armour Ammonia*

676. Carbon Refractories
Catalog section on carbon products for cupola furnaces gives physical properties of carbon refractories and describes applications. *National Carbon*

677. Carburizing
Bulletins A-1 and A-2 on liquid carburizing. Equipment, bath make-up and maintenance, cyanide analysis. *Park Chemical*

678. Castings
16-page booklet, "Cast to Outlast Destructive Service", gives latest information and case histories on use of sand, centrifugal and precision investment castings. *International Nickel Co.*

679. Castings
8-page Bulletin 13 on chromium-molybdenum gray iron. Applications, engineering and design data. *Advance Foundry*

680. Castings
Literature on shell or sand castings of ArmaSteel, malleable iron or gray iron. *Central Foundry Div.*

681. Centrifugal Castings
8-page brochure gives properties of most common grades of thermalloy centrifugally cast tube. Weight tables. *Electro-Alloys Div.*

682. Ceramics
4-page folder lists industrial products and bulletins describing them. *McDanel Refractory Porcelain Co.*

683. Chromate Coatings
Data sheets on Luster-on 50 conversion coating for manual or automatic plating. Bath make-up, operating conditions, typical cycle. *Chemical Corp.*

952. Surface Treatment
Metal cleaning is discussed in detail in this 84-page book. Data on types of soil, mechanical, chemical (acid and alkaline), solvent, emulsion and cold cleaning take up 44 pages. Helpful suggestions are made on testing of cleaning baths,



ways to improve efficiency of still tanks, rinse tank designs. Discussions of phosphating, blackening, rust prevention and pickling tank inhibitors are also included. Tabular data on tank make-up and capacity of rectangular tanks conclude the book. *E. F. Houghton & Co.*

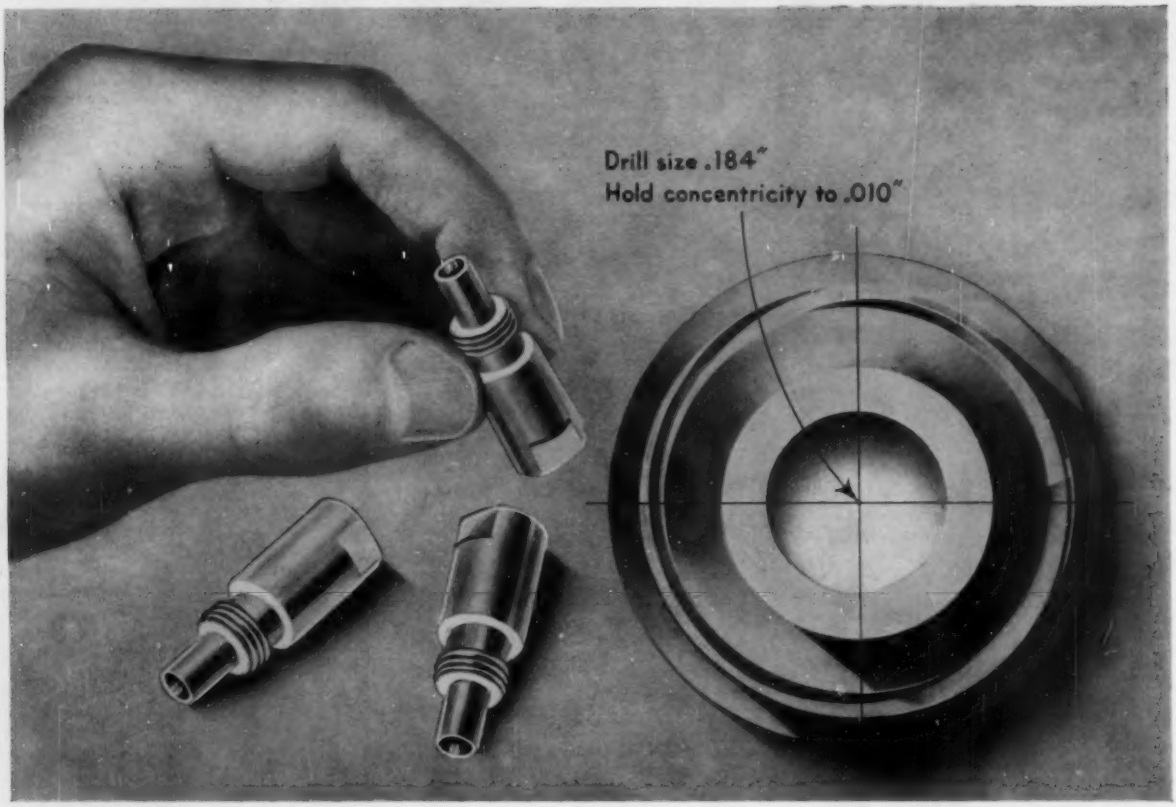
684. Chromate Finishing
File on chromate conversion coatings for prevention of corrosion and paint-base treatment of nonferrous metals. *Allied Research Products*

685. Chromium Plating
4-page bulletin on new "crack-free" chromium plating process. *Metal & Thermit*

686. Chromium Stainless
12-page book on fabrication and use of Type 430 stainless steel. *Sharon Steel*

687. Cleaners
Folder on immersion, electrolytic, spray cleaners, phosphate coaters, strippers, drawing compounds, additive agents. *Northwest Chemical*

How Anaconda can help you get the exact Rod to fit the job



THE broad line of Anaconda free-cutting copper and copper-alloy rods gives you widest latitude in selecting from warehouse stock the precise rod for most screw machine jobs. But every once in a while there are special requirements.

One company's problem: The M. J. Grass Screw Machine Products Co., Buffalo, N. Y., machines a part for a gas-burner base from ½" round free-cutting brass rod. Specifications call for a hole $1\frac{1}{16}$" deep by .184" in diameter—with concentricity held to .010".

With standard free-cutting brass rod the drill had a tendency to wander, running the concentricity off as much as .024". To correct this, The American Brass Company provided rod stock with a minor variation in fabrication for deep drilling. This free-cutting brass rod has a slightly harder core, which minimizes the tendency of the drill to run off center at the high drilling speeds used. Now M. J. Grass holds the concentricity to .008" or under. With regular free-cutting brass, rejects ran as high as 15%. With the deep-drilling rod, there are no rejects.

Your requirements: Anaconda Rods are consistently uniform in composition, temper, and free-cutting characteristics. Consequently, they make possible easy duplication of cutting speeds and feeds known to be satisfactory from previous job records.

When you need special physical characteristics, such as a harder core for deep drilling or additional ductility to permit spinning or cold forming after machining, either the temper, the alloy, or both can be adjusted to meet your requirements.

Free technical service: It is the function of the Technical Department of The American Brass Company to assist metal users in the solution of special problems. This service is at your disposal without charge.

Comprehensive data on composition and machinability of standard Anaconda Alloys, standard specifications, weights, and dimensions of standard rods is available in Publication B-3. For this booklet – for special technical assistance – write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5770

ANACONDA® RODS FOR SCREW MACHINE PRODUCTS

MADE BY THE AMERICAN BRASS COMPANY

688. Cleaning
44-page booklet, "Some Good Things to Know About Metal Cleaning", discusses tank, barrel and machine cleaning, pickling, zinc phosphate coating, rust prevention and other processes. *Oakite*

689. Cleaning
20-page booklet on machinery for spray washing and pickling, phosphatizing, drying, vapor degreasing, heat treating and other metal parts processing. *Metalwash Machinery Corp.*

690. Cleaning
5-page Bulletin 86 on improving properties of brass and copper surfaces with ammonia persulfate. *Becco Chemical*

691. Coated Metals
New bulletin on roll coating shows how it is done and includes samples. *Roll Coater, Inc.*

692. Coating
12-page bulletin on plastic coating materials. Methods of application, uses, variety in color and properties. *Chemical Products Corp.*

693. Coatings
4-page catalog on heat-proof protective coatings. Basic types, applications, methods of applying and temperature ranges. *Markal Co.*

694. Cold Forming
4-page folder on die-form process for cold reduction of steel bars into multi-diameter shaft blanks for finish turning or grinding. *Republic Steel*

695. Compressors
12-page bulletin 126-A on application of turbo compressors to oil and gas-fired equipment used in heat treating, agitation, cooling, drying. Performance curves, capacities. *Spencer Turbine*

696. Controlled Atmospheres
Illustrated literature describes controlled atmosphere installations. *Gas Atmospheres, Inc.*

697. Controllers
16-page educational bulletin No. 9 gives data, operation diagrams, schematic drawings of capacitrols. *Wheelco Instruments*

698. Conveyors
Bulletin MF-200 on conveyor standardization describes sections for making customized conveyors. *May-Fran Engineering*

699. Copper Alloys
40-page technical data book on eleven copper alloys. Properties, cleaning, annealing. *Seymour*

700. Corrosion Inhibitor
Folder on corrosion inhibitor for aluminum and steel. Applications. *Virginia-Carolina Chemical Corp.*

701. Creep Testing
Data sheet on stress rupture and creep testing machine. Operation, calibration, maintenance, specifications. *Tinius Olsen*

702. Cut-Off Machine
Bulletin 2237-J on abrasive-wheel cutting-off machine. Components, typical cuts. *American Instrument Co.*

703. Cutting Tools
36-page booklet analyzes and compares carbon, high speed, cast alloy and carbide tool materials. *Allegheny Ludlum*

704. Decimal Equivalents
2-color wall chart gives decimal equivalents. *Peninsular Steel Co.*

705. Decimals
Wall chart 16 by 23 in. of decimal equivalents. *John Hassall, Inc.*

706. Definitions
36-page glossary of over 150 terms on cast iron. *International Nickel*

707. Degreasers
Folder on vapor and solvent degreasers describes equipment and advantages. *Randall Mfg.*

708. Degreasing
Bulletin on OPNT vapor degreaser describes and diagrams its construction. *Circo Equipment*

709. Degreasing
40-page book on trichlorethylene gives specifications, properties, uses, handling and storage, toxicity and safety measures. *Hooker Electrochemical Co.*

710. Die Casting
Illustrated catalog on complete line of die casting machines. *Kux Machine*

711. Die Steel
Folder and stock list on Olympic FM air hardening, high carbon-high chromium die steel with sulphide additives for improved machinability. *Latrobe Steel Co.*

712. Ductile Iron
2-page Bulletin 14 describes characteristics, production, effect of heat treatment, types. *Advance Foundry Co.*

713. Electric Furnace
4-page bulletin 515 on high-temperature electric furnace. Design and construction. *Burrell Corp.*

714. Electric Furnace
Bulletin 5610 on rocking electric furnace with motor-driven electrodes. Ratings, special features and characteristics. *Detroit Electric Furnace Co.*

715. Electric Furnaces
Bulletin 441 on box-type electric furnaces diagrams and describes the furnaces and lists specifications. *Hevi Duty*

716. Electric Furnaces
12-page bulletin on box-type electric furnaces for toolroom applications. Performance data. *Westinghouse*

717. Electric Furnaces
8-page Bulletin 570 on heat treating, melting, metallurgical tube, research and sintering furnaces. Custom designs for special requirements. *Pereny*

718. Electric Heating
4-page bulletin on electric heating elements for pipe, tube and tank heating. Sizes, temperature control, element life and installation discussed. *Cooley Electric Mfg. Corp.*

719. Electrocoated Wire
8-page bulletin on new wire materials—Nickelply and Brassply, electrocoated steel wire. How it may be formed, bent and twisted without breaking the coating. *National Standard*

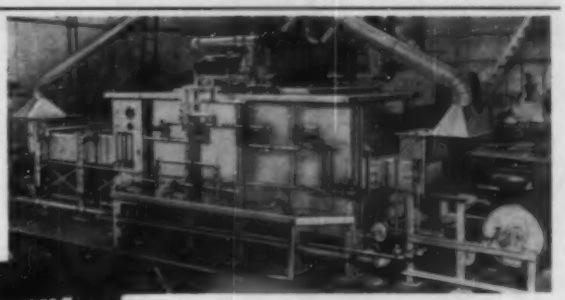
720. Electrolytic Metals
New 4-page folder on analysis and specifications of electrolytic chromium and manganese. Uses and properties. *Electro Metallurgical Co.*

721. Electron Tubes
12-page bulletin on industrial use and proper care of electron tubes. Log sheets for tube life records. *Machlett Laboratories*

722. Electronic Heaters
Bulletin GEA-6388 on electronic induction heaters. Specifications, design and construction. *General Electric Co.*

723. Finishing
New 52-page barrel finishing handbook. Modern processes described. *Almco Div.*

724. Firebrick
28-page bulletin R-34 on properties and



Gas-fired furnace for bright annealing sterling and nickel silver hollow ware and flatware; equipped with water spray cooling chamber.

for Continuous Accurate Bright Annealing Brazing · Sintering

ROCKWELL *Automatic* Belt Conveyor Furnaces

Electric · Gas · Oil

In Rockwell Belt Conveyor Furnaces work moves continuously in a "thin" layer with uniform exposure of pieces to heating and cooling under "controlled" operating conditions.... The conveyor is self-emptying.... It can be kept entirely within the furnace, thereby retaining heat, or it may move through a cooling zone or discharge work into a quench tank.... Operating labor cost is low.... There need be no carrying pans or fixtures to load or handle. Material can be charged directly onto the conveyor.

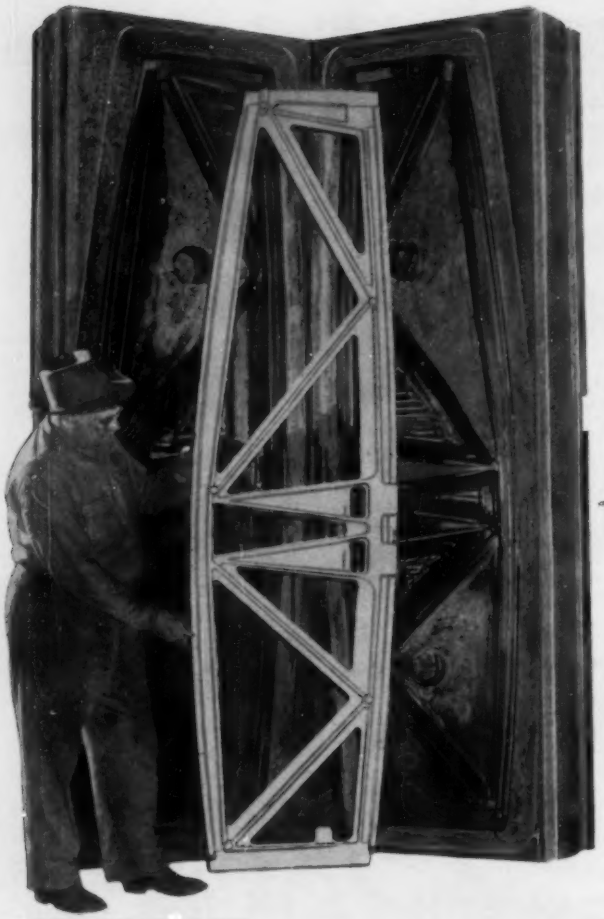
The extensive Rockwell design file of belt conveyor furnaces has made them practically standard for a great many heating operations. Write for bulletin.

W. S. ROCKWELL COMPANY

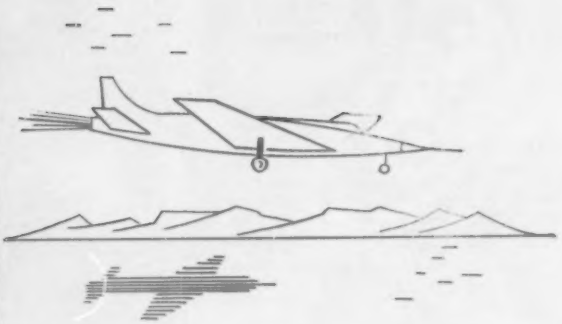
FURNACES • OVENS • BURNERS • VALVES • SPECIAL MACHINERY

2047 ELIOT STREET • FAIRFIELD, CONN.

Sales Representatives in Principal Cities



COURTESY ALUMINUM COMPANY OF AMERICA



Increase Production

with FINKL DIE BLOCKS

...the aircraft industry does!

These two 14 x 35 x 114" FX die blocks, made from Finkl electric furnace steel, and weighing 15,800 pounds each, are used for producing precision aluminum landing gear rib forgings.

Finkl FX die blocks are noted for their long production runs and economy because:

- FX covers the full usable hardness range from Temper H (477-444 BHN) to Temper 4 (293-269 BHN).
- FX produces the greatest number of forgings per impression because its well balanced alloy content offers uniform hardness and freedom from temper brittleness. Relatively high tempering temperature promotes ductility and elimination of residual stresses.
- FX Special Machining Quality appreciably reduces shanking and sinking time.

These proved advantages can also mean savings to you with more pieces per die and better deliveries to your customers.

Save money by talking to a Finkl representative the next time you are considering die blocks or forgings.

DIE BLOCKS · FORGINGS · HOT WORK STEELS · ELECTRIC FURNACE STEELS

A. Finkl & Sons Co.

2011 SOUTHPORT AVE · CHICAGO 14, ILLINOIS

Offices in: DETROIT · CLEVELAND · PITTSBURGH · INDIANAPOLIS · HOUSTON · ALLENTOWN · ST. PAUL
COLORADO SPRINGS · SAN FRANCISCO · SEATTLE · BIRMINGHAM · KANSAS CITY
Warehouses in: CHICAGO · DETROIT · BOSTON · LOS ANGELES

characteristics of 5 kinds of firebrick. Typical applications. Tables of brick quantities for arches of different sizes and shapes. *Babcock & Wilcox Refractories*

725. Flow Meter

12-page bulletin 115 on meter for flow metering and control. Tubes, floats, and accessories. Installation and maintenance. *Brooks Rotameter Co.*

726. Fluoroscopy

12-page booklet on fluoroscopy for nondestructive internal inspection. Explains image amplifier. *Westinghouse Electric, X-Ray Dept.*

727. Forging

Cost study compares seamless long welding necks and built up necks. *Lenape Hydraulic Pressing & Forging Co.*

728. Forging Machinery

32-page book No. 165 on design of dies for upsetting forging machines also includes machines, representative parts tables of decimal equivalents and areas of circles. *Ajax Mfg. Co.*

729. Forgings

94-page book on die blocks and heavy-duty forgings. 20 pages of tables. *A Finkl & Sons*

730. Forgings

Series of articles on modern forging methods. *Hill Acme*

731. Forgings

Handsome 32-page brochure on large forgings for turbine shafts, rotors, drop hammer anvils, rolls. *U.S. Steel*

732. Forgings

12-page booklet on how forged weldless rings and flanges are made. Case histories. *Standard Steel Works Div., Baldwin-Lima-Hamilton*

733. Forgings

16-page bulletin B-9 illustrates and tells advantages of die-pressed forgings. Copper alloys suitable for process. *American Brass*

734. Forgings

12-page booklet on aluminum, brass and copper forgings. Parts forged and their advantages. Properties of alloys used. *Revere Copper & Brass*

735. Formed Shapes

26-page catalog No. 1555 contains drawings and dimensions of more than 100 shapes. *Roll Formed Products Co.*

736. Free-Machining Steel

8-page bulletin gives machinability, heat treatment, fatigue resistance, and tensile properties for 0.45% carbon steel. *Horace T. Potts Co.*

737. Furnace

4-page bulletin SC-173 on suspended hearth furnace with radiant heating. Case history, atmosphere equipment. *Surface Combustion*

738. Furnace Brazing

Folder gives correct procedures for furnace brazing. Design for furnace brazing, brazing materials, atmospheres. *American Platinum*

739. Furnace Elements

24-page Bulletin H on electric heating elements. Includes extensive tabular data on physical and electrical specifications for various sizes. *Globar Div., Carborundum*

740. Furnace Charging

12-page brochure on eight models of charging machines for heating and melting furnaces. *Salem-Brosius*

741. Furnace Leads

Water-cooled leads for induction furnaces described in Inducto Metal Melting Newsletter, No. 4. Advantages. *Inductotherm*

742. Furnace Loader

Bulletin on loader for heat treat furnaces. *Michigan Crane & Conveyor*

743. Furnaces

Catalog on standard and special furnaces and ovens to 3000° F. *L & L Mfg.*

744. Furnaces

6-page folder on industrial furnaces with maximum temperatures of 850 to 1250° F. Diagrams of heat circulation. Performance features. *Despatch Oven*

745. Furnaces

4-page bulletin on conveyor furnaces for operation to 2100° F. Specifications of standard straight through and "humpback" furnaces. *C. I. Hayes*

746. Furnaces

Bulletin on electric heat treating furnaces describes five series and accessories. *Lucifer Furnaces*

747. Furnaces

16-page bulletin 135 on industrial furnaces and atmosphere generators. Continuous systems. *Continental Industrial Engineers*

748. Furnaces

High-temperature furnaces for temperatures up to 2000° F. *Carl-Mayer Corp.*

749. Furnaces

12-page reprint on design, construction and application of chain belt conveyor furnaces. *Electric Furnace Co.*

750. Furnaces

Folder on recirculating furnaces illustrates and describes 9 models and endothermic gas generator. *Standard Fuel Engineering Co.*

751. Furnaces

Bulletin 435 on furnaces for tool room, experimental or small batch production. Gas, oil, electric. Muffle or direct heated. *W. S. Rockwell*

752. Furnaces

Series of bulletins on controlled atmosphere, carburizing, nitriding, hardening furnaces. *American Gas Furnace*

753. Furnaces

Folder describes complete set up for heat treatment of small tools, including draw furnace, quench tank and high temperature furnace. *Waltz Furnace*

754. Gas Analyzer

Bulletin 175 on sonic analyzer gives principle of operation, method of measurement, sensitivity. *National Instrument Laboratories, Inc.*

755. Gas Generator

Bulletin 157 on endothermic generator. Operation, special features and specifications given. *Hevi-Duty Electric Co.*

756. Gas Generator

Data on endothermic gas generator with self-cleaning action. *Connecticut Gas Atmospheres*

757. Gold Plating

Physical, thermal, chemical, electrical, diffusion and optical properties of electroplated gold. Uses. *Technic, Inc.*

758. Grinding and Polishing

New accessory list for abrasive belt unit. Specifications and operation of continuous abrasive belt machine. *Grinding & Polishing Machinery Corp.*

759. Hardness Conversions

Desk-size chart of conversions for Rockwell tests and other hardness scales. *Torsion Balance Co.*

760. Hardness Tester

Bulletin on Brinell tester with test

BURRELL

"For Scientists Everywhere"

LABORATORY FURNACES

BURRELL *DUAL-RANGE*

Box and Muffle Type

FOR HIGH TEMPERATURES
UP TO 2650° F.



Model 30 (pictured) Automatic temperature control. From 600° F. to 2000° F., use for ashing, drawing, igniting, tempering, etc. Above 2000° F., for sintering, melting, clinkering, fusing and high speed hardening. For use with 230 volts, 50-60 cycles, single phase power supply; automatic controller for 115 volts, 50-60 cycles, single phase.

CAT. NO.	ITEM	PRICE
37-442	Box and Muffle Type Furnace, Model 30— (Heating chamber 7" wide x 8¼" deep x 4" high)	1500.00

Price listed is F.O.B. Pittsburgh, Pa.

For other models—ask for Bulletin No. 315

BURRELL CORPORATION
Scientific Instruments and Laboratory Supplies
2223 Fifth Avenue, Pittsburgh 19, Pennsylvania

SUCCESSFULLY BRAZED WITH



SWECO

SOUTHWESTERN ENGINEERING COMPANY

Southwestern Engineering Company, designers and manufacturers of heat exchangers, pressure vessels and special fabricated equipment for the process industries. ★ ★ ★ ★

Here's a brazing job that was no easy problem. It is being done now successfully thanks to the engineering ingenuity of Southwestern Engineering Company personnel. This is a "first" for this type of brazing operation on the West Coast. Twenty-four of these heat exchangers are already in service in Texas oil fields and many more will follow.

The tube sheets are for large diameter exchangers. Brass plate, ¾" thick, is brazed to 3¾" thick steel plate with .005 x 6" Silvaloy 45 and APW Black Flux. Furnace heating was used.

Silvaloy Brazing Alloys and APW Fluxes are helping to speed production, lower costs and improve brazing results in many fields. Call your nearest Silvaloy Distributor for information or technical assistance. ★ ★

Two complete reference manuals for low temperature silver brazing and fluxing are available upon request. Send for either one or both. ★ ★ ★ ★



THE SILVALOY DISTRIBUTORS

BURDETT OXYGEN COMPANY
CLEVELAND • CINCINNATI
COLUMBUS • AKRON • DAYTON
YOUNGSTOWN • MANSFIELD • FINDLAY

EDGCOMB STEEL OF NEW ENGLAND, INC.
MILFORD, CONNECTICUT
NASHUA, NEW HAMPSHIRE

EAGLE METALS COMPANY
SEATTLE, WASH. • PORTLAND, ORE.
SPOKANE, WASH.

A.B.C. METALS CORPORATION
DENVER, COLORADO

OLIVER H. VAN HORN CO., INC.
NEW ORLEANS, LOUISIANA
FORT WORTH, TEXAS
HOUSTON, TEXAS

NOTTINGHAM STEEL COMPANY
CLEVELAND, OHIO

EDGCOMB STEEL COMPANY
PHILADELPHIA, PA. • CHARLOTTE, N.C.
BALTIMORE, MD. • YORK, PA.
KNOXVILLE, TENN.

PACIFIC METALS COMPANY LTD.
SAN FRANCISCO, CALIFORNIA
SALT LAKE CITY, UTAH
LOS ANGELES, CALIFORNIA
SAN DIEGO, CALIFORNIA

STEEL SALES CORPORATION
CHICAGO, ILL. • MINNEAPOLIS, MINN.
INDIANAPOLIS, IND. • KANSAS CITY, MO. • GRAND RAPIDS, MICH.
DETROIT, MICH. • ST. LOUIS, MO.
MILWAUKEE, WIS.

LICENSED CANADIAN MANUFACTURER
BAKER PLATINUM OF CANADA, LTD.
TORONTO • MONTREAL

THE AMERICAN PLATINUM WORKS

231 NEW JERSEY RAILROAD AVE. • NEWARK 5, N. J.

NEW YORK • PROVIDENCE • CHICAGO • SAN FRANCISCO • LOS ANGELES

APW — LOW TEMPERATURE SILVER BRAZING ALLOYS AND FLUXES

ENGELHARD INDUSTRIES

head for deep and offset testing. *King Tester*

761. Hardness Tester

4-page bulletin on portable metal hardness tester for any shape or metal. Ranges, features. *Newage Industries*

762. Hardness Tester

Bulletin A-16 on micro-reflex hardness testers. Loads to 3000 gr. Zeiss optical system. *Gries Industries, Inc.*

763. Hardness Tester

20-page book on hardness testing by Rockwell method. *Clark Instrument*

764. Hardness Tester

Data on hardness testing scleroscope with equivalent Brinell and Rockwell C numbers. *Shore Instrument*

765. Hardness Tester

Bulletin on Impressor portable hardness tester for aluminum, aluminum alloys and soft metals. *Barber-Colman*

766. Hardening Tool Steels

4-page bulletin on complete line of hydryzing furnaces. Diagrams, specifications and performance data on preheat and high speed furnaces. *Lindberg Engineering*

767. Heaters

Bulletin on immersion heaters for electroplating solutions. *Glo-Quartz*

768. Heating Elements

24-page booklet on elements for electric furnaces and kilns includes technical data, uses, physical and electrical specifications. *Norton*

769. Heat Treating

12-page bulletin on heat treating equipment. Applications and special features of 19 different types of furnaces including shaker hearth, conveyor, high vacuum, elevator-type brazing. *Pacific Scientific*

770. Heat Treating

Case histories of carburizing and hardening leaded steel shafts and precipitation hardening beryllium-copper parts in Ipsenlab, No. 14. *Ipsen Industries*

771. Heat Treating

20-page catalog on the Homocarb method with Microcarb atmosphere control for heat treatment of steel. *Leeds & Northrup*

772. Heat Treating

Bulletin 14-T on ovens for heat treatment of aluminum and other low-temperature processing. *Young Bros.*

773. Heat Treating

Bulletin describes baskets, crates, trays, furnace parts. *Stanwood*

774. Heat Treating

Monthly bulletin on used heat treating and plating equipment, available for immediate delivery. *Metal Treating Equipment Exchange*

775. Heat Treating Ammonia

24-page "Guide for Use of Anhydrous Ammonia" describes heat treating and other metallurgical uses. *Nitrogen Div.*

776. Heat Treating Belts

Catalog of conveyor belts and data for their design, application and selection. *Ashworth Bros.*

777. Heat Treating Fixtures

24-page catalog on heat and corrosion-resistant equipment for heat treating and chemical processing. 30 classifications of equipment. *Pressed Steel*

778. Heat Treating Fixtures

4-page folder on retorts, baskets, trays, carburizing boxes, fans for heat treating. *Aluminum & Architectural Metals Co.*

779. Heat Treating Fixtures

New 32-page catalog G-10A lists process equipment, heavy welded fabrications, muffles, trays, fixtures for furnaces, heat-treating equipment, pickling equipment. *Rolock*

780. Heat Treating Fixtures

Folder on carburizing boxes, trays, heat treat fixtures and baskets. *Misco*

781. Heat Treating Furnaces

12-page booklet on various heat treating furnaces contains chronology of advances. *Holcroft*

782. Heat Treating Pots

Bulletin 110 gives data on sizes and shapes of cast nickel-chromium solution pots. *Fahralloy*

783. Heat Treating Supplies

Data sheets on carburizing, hardening, tempering, nitriding salts, metal cleaning and rust prevention materials. *Heatbath*

784. High-Alloy Castings

16-page bulletin, No. 3354-G, gives engineering data concerning castings used for resisting high temperatures, corrosion and abrasion. *Duraloy Co.*

785. High-Temperature Alloy

14-page bulletin on Udimet 500 gives composition, heat treatment, machinability, hot working characteristics and properties. *Utica Drop Forge and Tool*

786. High-Temperature Alloys

Booklet "Keep Operating Costs Down When Temperatures Go Up." *International Nickel*

787. High-Temperature Alloys

"Haynes Alloys for High-Temperature Service" summarizes all available data on 10 superalloys and lists physical and mechanical properties of two newly developed alloys. *Haynes Stellite*

788. High-Tensile Steel

8-page bulletin on properties and composition of N-A-X high-tensile steel. Examples of resistance to impact, fatigue, abrasion and corrosion. *Great Lakes Steel*

789. High-Strength Steel

66-page catalog on Mayari°R steel. Applications which take advantage of its wear and corrosion resistance. *Bethlehem Steel*

790. High-Strength Steel

Data on low alloy steel. Chemical analysis, physical properties. *Youngstown Sheet & Tube*

791. High-Vacuum Equipment

New 24-page catalog on high-vacuum equipment for laboratory and industry. Pumps, valves, gages, leak detectors, metallizing equipment and furnaces described. *Rochester Div., Consolidated Electrodynamics Corp.*

792. Induction Heaters

8-page bulletin EH 57-6 on electronic induction heaters. Specifications, basic components, guide to brazing and soldering and frequency selection chart are included. *Magnethermic*

793. Induction Heating

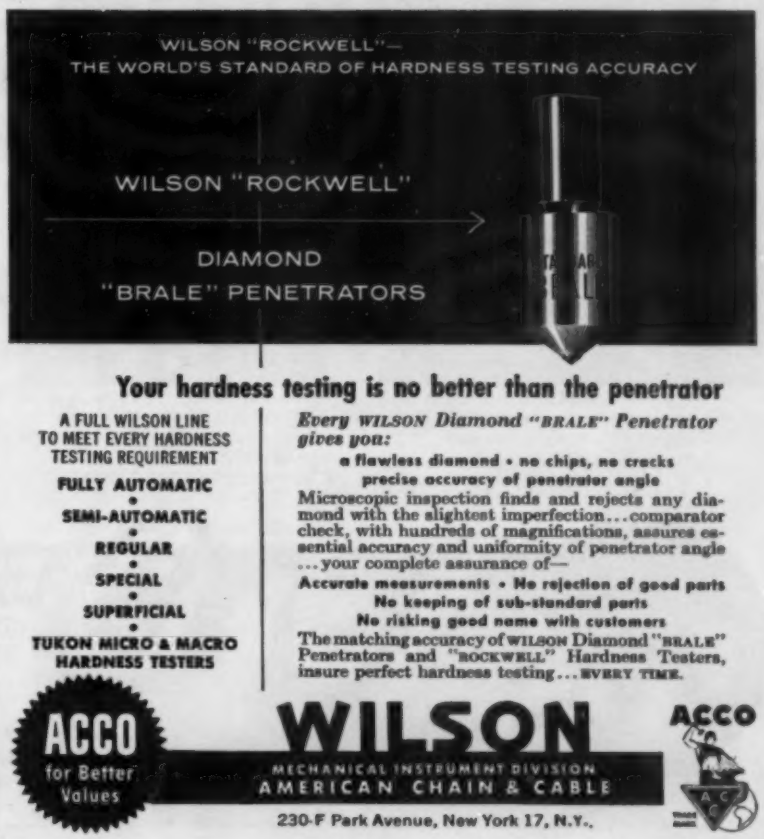
12-page booklet B-6519 on equipment for induction heating for forging, hardening, annealing and metal joining. *Westinghouse Electric*

794. Induction Heating

8-page catalog section 22C on induction heating for forming and forging. Advantages of induction heat. *Ohio Crankshaft*

795. Induction Heating

36-page bulletin on high-frequency induction heating unit for brazing, hardening, soldering, annealing, melting and bombarding. *Lepel*



Your hardness testing is no better than the penetrator

A FULL WILSON LINE TO MEET EVERY HARDNESS TESTING REQUIREMENT

FULLY AUTOMATIC • SEMI-AUTOMATIC • REGULAR • SPECIAL • SUPERFICIAL • TUKON MICRO & MACRO HARDNESS TESTERS

Every WILSON *Diamond "BRALE" Penetrator gives you:*

a flawless diamond • no chips, no cracks
precise accuracy of penetrator angle

Microscopic inspection finds and rejects any diamond with the slightest imperfection... comparator check, with hundreds of magnifications, assures essential accuracy and uniformity of penetrator angle ...your complete assurance of—

Accurate measurements • No rejection of good parts
No keeping of sub-standard parts
No risking good name with customers

The matching accuracy of WILSON Diamond "BRALE" Penetrators and "ROCKWELL" Hardness Testers, insure perfect hardness testing... EVERY TIME.

ACCO for Better Values

WILSON
MECHANICAL INSTRUMENT DIVISION
AMERICAN CHAIN & CABLE

230-F Park Avenue, New York 17, N.Y.

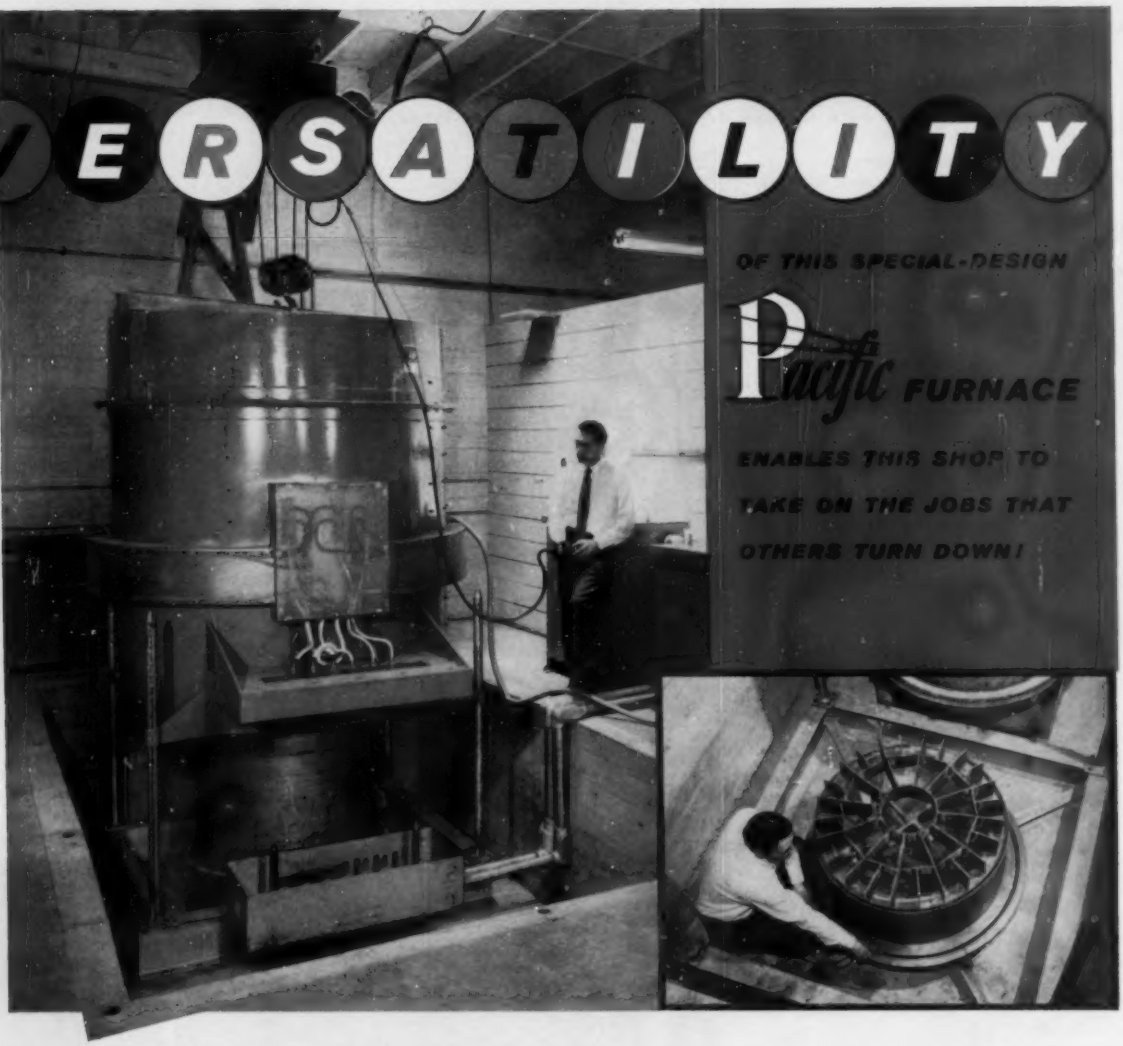
ACCO

VERSATILITY

OF THIS SPECIAL-DESIGN

Pacific FURNACE

ENABLES THIS SHOP TO TAKE ON THE JOBS THAT OTHERS TURN DOWN!



Specializing in tough heat treating jobs—"the ones that other shops like to steer clear of"—Metallurgical Consultants, Inc. of Maywood, California has recently installed one of the largest commercial brazing furnaces in the West!

This new Pacific Furnace was built for the special requirements of MCI where precision heat treating to close tolerances, uniformity and metallurgical properties are demanded.

Used primarily for precise nitriding of oil tools, aircraft and precision instrument parts in the lower temperature ranges, this same furnace is designed for high temperature work such as hydrogen brazing of titanium, hydrogen annealing and vacuum outgassing.

Some of the features which allow this versatility are the fan design which develops good temperature uniformity even at low temperatures, and an improved water-cooled seal to maintain absolute purity of the furnace atmosphere.

Electrically heated, the furnace is seven feet high with a six foot diameter, and can provide controlled temperatures in its two-zone heating chamber up to maximum of 2250° F.

Three other Pacific Furnaces, two of which are used with vacuum atmospheres plus a new automatic quench furnace, are also on the job in producing the "specialized" heat treating service that MCI is known for!

You can put Pacific's knowledge and experience to work on your heat treating problems. Write or call today!

*TRADE MARK



A total of four Pacific Furnaces are on the job at MCI

Pacific INDUSTRIAL HEAT TREATING EQUIPMENT

PACIFIC SCIENTIFIC COMPANY

LOS ANGELES
SAN FRANCISCO
SEATTLE
PORTLAND, ORE.
ARLINGTON, TEX.
SAN DIEGO

PACIFIC SCIENTIFIC COMPANY
P. O. Box 22019, Los Angeles 22, Calif.

☐ Please send the new General Catalog of Pacific Heat Treating Equipment.

☐ Please send me all information available on a furnace for _____ (type of work)

Name _____

Company _____

Address _____

City _____ State _____

796. Induction Heating
12-page bulletin gives descriptions, technical data on various sizes. Water systems diagrams and standard accessory equipment. *High Frequency Heating Div., Lindberg Engineering*

797. Induction Melting
Bulletin 70 on furnace. Controls, designs. *Inductotherm Corp.*

798. Infrared Analyzer
4-page data sheet on infrared gas analyzer describes instrument, its operation and maintenance. *Leeds & Northrup*

799. Infrared Heating
New 8-page brochure on applications of radiant heating equipment. Ovens and components. *Fostoria Pressed Steel*

800. Instruments
12-page condensed catalog of instruments and controls for pressure, flow, temperature, gas analysis. *Hays Corp.*

801. Investment Castings
4-page folder on frozen-mercury and lost-wax processes for ferrous and nonferrous metals. *Alloy Precision Castings*

802. Laboratory Equipment
32-page bulletin on scientific apparatus and methods includes a 16-page discussion of the recorder. Catalog of other apparatus including combustion furnace, carbon analyzers. *E. H. Sargent & Co.*

803. Laboratory Furnace
Bulletin RT-10 on 25 lb. per hr. laboratory metal treating unit for carburizing, hardening, carbonitriding, brazing, carbon restoration. *Ipsen*

804. Laboratory Mill
4-page reprint on rolling mill for laboratory studies, which may be operated as a 2-high, 3-high or 4-high mill. *Fenn Mfg.*

805. Laboratory Ware
20-page booklet on polyethylene laboratory ware including beakers, bottles, tubing, matting. *Harshaw Scientific*

806. Leaded Steels
New 16-page booklet on basic characteristics, mechanical properties and workability of leaded steels. Case histories. *Copperweld Steel Co.*

807. Low-Temperature Brazing
Folder on brazing copper to nichrome, stellite to steel, brass to brass, steel to cast iron. *Handy & Harman*

808. Lubricant
Bulletin 426 on use of colloidal graphite for forging, wire drawing, piercing, drawing, extrusion and other metalworking operations. *Acheson Colloids*

809. Lubricant
Fact sheet on high-temperature lubricant for parts operating in oven temperatures over 400° F. *Tower Oil Co.*

810. Lubricant
8-page booklet, "Biggest Ounce of Protection", tells of lubrication with colloidal graphite products. *Grafo Colloids*

811. Lubricant
8-page folder describes use of molybdenum disulfide lubricant in cold forming, cold heading and other applications. Case histories. *Alpha Molykote Corp.*

812. Machining Costs
12-page "Relation of Machining Time to Material Cost". Comparative machinability costs per ton for eleven steels. *La Salle Steel*

813. Machining Stainless
16-page booklet on drilling, tapping, thread chasing, turning, milling, broaching. Machinability rating of stainless steels. *Crucible Steel Co.*

814. Manganese
9-page article on electromanganese. Manufacturing procedures, product characteristics, uses. In Foote Prints, V. 28, No. 2. *Foote Mineral Co.*

815. Master Alloys
24-page pocket bulletin on high alloy materials for remelting purposes also includes metric equivalents tables, element melting points, temperature conversion tables. *Alloy Metal Products*

816. Meehanite Castings
4-page data folder on the heat treatment of different grades of Meehanite castings. Improving strength, toughness and hardness. Austempering, martempering. *Meehanite Metal Corp.*

817. Melting Furnaces
48-page book 9A on line of standard furnaces from research to 200-ton steel mill types. *Lectromelt Furnace Div.*

818. Metal Cutting
8-page booklet 5705 on airbrasive cutting of hard, brittle materials. Specifications, how it works, applications. *S. S. White Industrial Div.*

819. Metallographic Polishing
16-page article in Metal Digest. V. 1, No. 4, on features of various models of metallographic polishing equipment. *Buehler, Ltd.*

820. Metal Powders
16-page booklet on CDF iron powder. Briquetting characteristics, green strengths, iron sinters, iron-copper mixes, iron-copper bushings and iron-copper-carbon mixes. *Republic Steel*

821. Metalworking Saws
New 64-page catalog 31 of burs, files, grinding points, metalworking saws, voltammeters, electric etchers. *Martindale Electric Co.*

822. Microhardness Tester
Bulletin describes the Kentron microhardness tester. *Torsion Balance Co.*

823. Microscopes
Catalog on metallograph and several models of microscopes. *United Scientific*

824. Microscopes
22-page catalog describes microscopes featuring ball bearings and rollers throughout the focusing system and a low-position fine adjustment, providing comfortable operation. *Bausch & Lomb*

825. Moisture Measurement
12-page bulletin on how to measure water vapor in air and other gases. Gravometric, dew point and wet and dry bulb methods, and others. *Pittsburgh Lectrodryer.*

826. Molybdenum
72-page book gives data on unalloyed molybdenum and four arc-cast alloys. Several pages of references. *Climax Molybdenum*

827. Nickel Plating
16-page bulletin gives instructions for plating by the sulfamate nickel process. *Hanson-Van Winkle-Munning*

828. Nickel Tubing
New 20-page catalog gives properties and compositions of 13 analyses of nickel and nickel alloy tubing. Selection guide. *Superior Tube*

829. Nitriding
Data on process for nitriding stainless steel. *Standard Steel Treating*

830. Nonflammable Rust Preventive
Bulletin on rust preventive compound which is water soluble, nontoxic and nonflammable. *Production Specialties*



When it's WILSON "ROCKWELL"-TESTED *you KNOW it's RIGHT!*

Easy to operate—all controls at hand

Takes rough service—maintains accuracy after years of operation

Expert Wilson service—helps you choose proper model—keeps it at work

A staff of WILSON hardness testing experts is available to provide quick emergency service if it is ever needed.

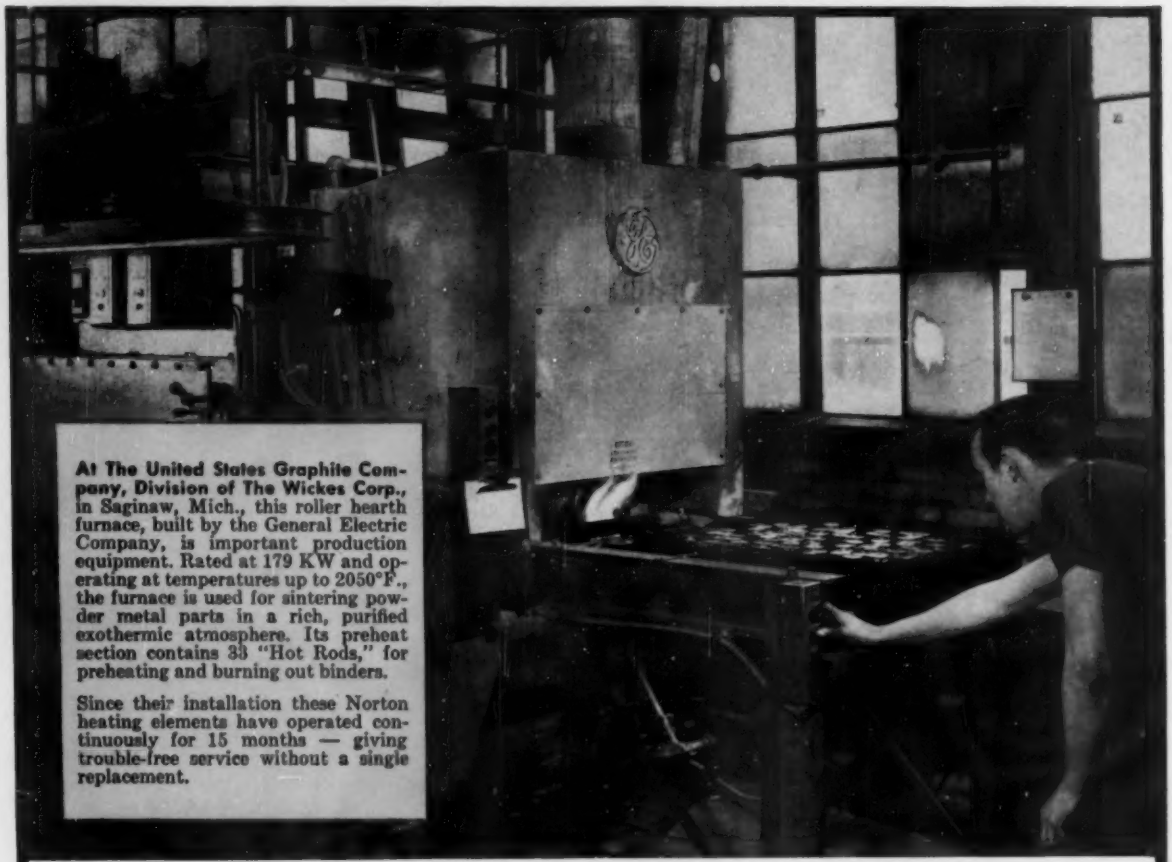
A FULL WILSON LINE TO MEET EVERY HARDNESS TESTING REQUIREMENT

FULLY AUTOMATIC • SEMI-AUTOMATIC • REGULAR • SPECIAL • SUPERFICIAL • MICRO & MACRO HARDNESS TESTERS

ACCO WILSON
MECHANICAL INSTRUMENT DIVISION
AMERICAN CHAIN & CABLE
230-F Park Avenue, New York 17, N.Y.



Write for booklet DH-325 today



At The United States Graphite Company, Division of The Wickes Corp., in Saginaw, Mich., this roller hearth furnace, built by the General Electric Company, is important production equipment. Rated at 179 KW and operating at temperatures up to 2050°F., the furnace is used for sintering powder metal parts in a rich, purified exothermic atmosphere. Its preheat section contains 33 "Hot Rods," for preheating and burning out binders.

Since their installation these Norton heating elements have operated continuously for 15 months — giving trouble-free service without a single replacement.

At The United States Graphite Company...

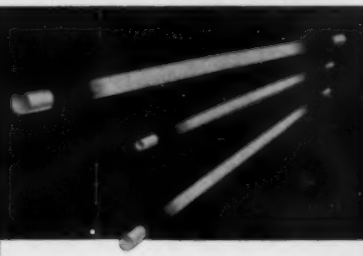
"HOT RODS" give long lasting service life

Norton CRYSTOLON heating elements are excellent performers in an Electric Sintering Furnace*

Norton "Hot Rods" are outlasting other non-metallic heating elements *up to 3 to 1!* Such reports from many plants mean that you too can save with these heating elements, because they need less replacing than other elements. Also, you get reduced maintenance, due to less changing of elements or voltage taps. And "Hot Rods" help protect product quality, because their slow, evenly matched rate of resistance provides more uniform heating.

For further facts on how "Hot Rods" can help improve your furnace operations and cut costs, send for booklet, *Norton Heating Elements.* NORTON COMPANY, Refractories Div., 328 New Bond St., Worcester 6, Mass.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries



Norton CRYSTOLON Heating Elements, or "Hot Rods," are a typical Norton R — an expertly engineered refractory prescription for greater efficiency and economy in electric kiln and furnace operations. Made of self-bonded silicon carbide, each rod has a central hot zone and cold ends. Aluminum-sprayed tips and metal-impregnated ends minimize resistance and power loss. Available in standard sizes.

NORTON

REFRACTORIES

Engineered... Rx ...Prescribed

Making better products... to make your products better

NORTON PRODUCTS
Abrasives • Grinding Wheels
Grinding Machines • Refractories

BEHR-MANNING DIVISION:
Coated Abrasives • Sharpening Stones
Behr-cut Tapes

831. Nondestructive Testing
8-page bulletin on equipment for nondestructive testing of bars, rods, tubing. *Magnetic Analysis*

832. Oil Quenching
Catalog FB-1052-A on self-contained oil cooling equipment. Selection tables for volume of oil required and oil recirculation rates. *Bell & Gossett*

833. Oil Quenching
8-page brochure tells in detail how carbon steel often can replace alloy steel when additive is used in the quenching oil. *Aldridge Industrial Oil*

834. Openhearths
12-page booklet shows how openhearths are built. Furnace binding, refractories, combustion and controls, and mechanical equipment. *Loftus Engineering*

835. Painting
Brochure on airless spray painting. *Bede Products*

836. Perforated Metals
New 4-page folder gives ordering specifications and patterns. *Wickwire Spencer Steel Div., Colorado Fuel and Iron Corp.*

837. Phosphor Bronze
4-page technical bulletin T-4 on advantages and fabrication of fine-grain phosphor bronze. *Riverside-Alloy Metal*

838. Photographic Films
Catalog of motion picture, radiographic and industrial films, photographic papers and luminescent chemical products. *DuPont*

839. Pickling Baskets
Data on baskets for degreasing, pickling, anodizing and plating. *Jelliff*

840. Pit Furnace
Bulletin 755 on pit furnace for temperatures to 1350° F. Uses, features, heat circulation, specification. *Hevi Duty Electric Co.*

841. Plated Strip
Bulletin on plated metal strip. Plating thicknesses and variations possible. *Sylvania Electric*

842. Plating
4-page bulletin ER-110 describes germanium rectifiers. Ratings of 4 models. Specifications, outstanding features. *Hanson-Van Winkle-Munning*

843. Potentiometers
4-page bulletin 1271 on small self-balancing electronic potentiometers and bridges. *Bristol Co.*

844. Powdered Metal
Folder on quality control of powdered metal production through use of test-bar service. *Hoeganaes Sponge Iron Corp.*

845. Powder Metallurgy
8-page reprint on parts made by sintering powdered metals. Advantages and limitations of the process. Surface treatment. *Pegasus International Corp.*

846. Powdered Metals
Booklet on design, properties, production and application of brass and other nonferrous powder parts. 24 case histories. *New Jersey Zinc*

847. Precious Metals
Data on bright gold, bright silver, rhodium plating and salts. *Sel Rex*

848. Precision Casting
8-page bulletin on investment castings of various ferrous and nonferrous alloys. *Engineered Precision Casting*

849. Precision Casting
12-page book on alloy selection and design for investment casting. *Arwood Precision Casting*

850. Precision Casting
12-page book tells when to use precision castings, tolerances, how castings are made. *Alexander Saunders*

851. Precision Castings
Pocket-sized book gives advantages and limitations of lost-wax process. Basic design principles as they apply to investment castings. *Midwest Precision Castings Co.*

852. Precision Castings
4-page reprint tells how light alloys are cast by the frozen mercury process. Applications, advantages. *Alloy Precision Castings Co.*

853. Presses
Data on mechanical and hydraulic powered metal presses 8 to 500-ton capacities. *Haller, Inc.*

854. Protective Coatings
Folder 301 on industrial protective coatings of rubber, neoprene and other materials. *Arco Steel Fabricators*

855. Pyrometer
8-page data sheet 0053 on Land radiation pyrometer. Construction, calibration, uses. *Fielden Instrument Div., Robertshaw-Fulton Controls Co.*

856. Pyrometer
6-page catalog 155 on immersion coating gives special features, instrument and thermocouple models. Comparison of bare metal and unprotected thermocouples. *Pyrometer Instrument*

857. Pyrometer Calibration
"Pyrometer Thermocouple Calibration Data" includes tables of data released by National Bureau of Standards. *Bristol*

858. Pyrometers
Data sheet 1E-1 on high-resistance indicating pyrometers. Special thermocouples for surface measurement, molten nonferrous metals, general immersion. *West Instrument Corp.*

859. Quenching
Data sheet 29 on quenching oil includes data on effect of agitation, advantages and specification. *Sun Oil*

860. Quenching Oils
4-page bulletin on 3 types of quenching oil gives advantages of each. *E. F. Houghton & Co.*

861. Radiography
New 12-page booklet on six different types of radiographic units. How each is used. *Philips Electronics*

862. Radiography
20-page bulletin on gamma radiography. Uses, sources, equipment. *Nuclear Systems Div., Budd Co.*

863. Radioisotopes
8-page booklet on cobalt-60, cesium-137, iridium-192 and how they are used in radiography. Gamma and X-ray radiography compared. *Ansco*

864. Rare Earths
12-page handbook on rare earth chemicals, thorium. Applications of rare earths. *Heavy Minerals Co.*

865. Rare Earths
8-page Progress Report Number 1, "Rare Earths in Iron and Steel Melting". *Molybdenum Corp.*

866. Recirculating Furnace
Bulletin on continuous-type recirculating furnace shows design of furnace, its operation and advantages. *Industrial Heating Equipment*

867. Refractories
12-page booklet on 6 types of fire brick. Tables of thermal data of vertical walls. Conductivities of insulating firebrick. *Harbison-Walker Refractories Co.*

868. Refractories
24-page booklet on how refractory grain is produced. Chemical and physical characteristics, sizes available, applications. *Norton*

869. Refractory
Bulletin on castable refractories. How to use them. Properties of four types. *Standard Fuel Engineering*

870. Refractory Metals
8-page bulletin on titanium and zirconium castings and ingots. Corrosion properties given in 3-page table. *Oregon Metallurgical Corp.*

871. Resistance Alloy
8-page catalog of copper-nickel resistance wire. Physical properties, specifications, resistance for 54 wire sizes and 31 ribbon sizes. *Hoskins Mfg.*

872. Resistance Welding
24-page catalog on equipment for resistance welding includes reference tables and property and application charts. *Ampco*

873. Rust Prevention
Data sheets describe solvent type and emulsifiable type rust resisting compounds. *John Swift Chemical*

874. Rust Remover
New 4-page folder on alkaline rust remover. How and where to use it. *Turco*

875. Salt Bath Furnaces
Reprint No. 145 on basic principles of electrode type salt bath furnaces gives methods of mechanization and applications. *Ajax Electric*

876. Salt Bath Furnaces
Data on salt bath furnaces for batch and conveyorized work. *Upton*

877. Salt Baths
Bulletin 200 tells about different types of baths and operating characteristics of each. Table of bath recommendations for various steels. *A. F. Holden*

878. Sample Preparation
4-page discussion of metallurgical polishing with Metadi, diamond compound, in Metal Digest, V. 3, No. 3. *Buehler, Ltd.*

879. Sand Blasting
4-page bulletin 1265 on sand blasting machines for cleaning, deburring, surface preparation. *Leiman Bros.*

880. Saws
Catalog C-55 describes 35 models of metal-cutting saws. *Armstrong-Blum*

881. Seamless Castings
4-page brochure on stainless steels and castings. Types of stainless in which castings are available. *Alloy Steel Casting Co.*

882. Shot and Grit
14-page catalog describes cast steel, malleable iron, chilled iron, cut wire and other forms of abrasive shot and grit. Methods of shot peening and impact cleaning. *Abrasive Shot & Grit Co.*

883. Sintered Carbides
24-page booklet on the characteristics of the various grades, for research and design engineers. *Kennametal*

884. Silicon Carbide
8-page booklet on silicon carbide refractory. High-temperature properties. Shapes. Design practices. *Refractories Div., Carborundum Co.*

885. Silver Brazing
8-page Bulletin B-80 on low temperature silver brazing alloy. Joint preparation, strength of brazed joint, ductility and corrosion resistance. *United Wire and Supply Corp.*

(*Continued on page 48-A*)

Save by using specialized refractories

Many refractories problems in metal-working furnaces have been solved *economically* by the use of B&W specialized refractory castables. Each ferrous or non-ferrous furnace application requires a specific combination of properties to meet the service conditions. Whether your problem is high temperatures, abrasion and erosion, slag attack or the need for insulation, to name a few, you will find the refractory castable best suited to your requirements in B&W's line. Shown here in digest form are data on the widely used B&W refractory castables for metal-working furnaces:

B&W Refractory Castables for Metal Working Furnaces

	Temp. F	PROPERTIES	TYPICAL APPLICATIONS
B&W Kaocast	3000	High resistance to spalling and slag attack. Low volume change and negligible reheat shrinkage.	Soaking pit covers, linings of high temperature heating and forging furnaces, burner blocks, electrode linings of electric furnace roofs, linings of non-ferrous metal furnaces.
B&W Kaocrete 32	3200	High strength, exceptional refractoriness, unusual volume stability, excellent resistance to spalling.	Can be used in applications similar to those of B&W Kaocast and where higher refractoriness is required.
B&W Kaocrete D	2500	Sufficient strength and hardness to withstand abrasion, considerable physical abuse and erosion.	Aluminum melting furnaces, linings and car tops in heat treating furnaces, as well as in sections of a wide variety of furnaces that are subject to scraping by hand tools or other mechanical abuse.
B&W Kaocrete A	2600	Resists reducing atmospheres. Has good resistance to erosion, abrasion and thermal shock.	Annealing furnace bases and other applications where resistance to reducing atmospheres is essential. Also as a general purpose castable for linings in medium temperature service.
B&W Kaocrete B	2300	Has an adhesive plastic texture particularly suited for vertical or overhanging constructions. Excellent for plastering.	Patching linings and baffles and for any application where plastering rather than gunning or casting is required.
B&W Kaocrete LI	2700	High alumina content, exceptionally high strength for resistance to abrasion and erosion.	Aluminum furnace linings where high alumina content is important.
B&W Kaolite 20	2000	Offers castable's fast, low cost installation plus insulation. Has refractoriness, light weight and low heat conductivity and, in addition, will resist reducing atmospheres. Can be poured or gunned.	Aluminum melting, heating and heat-treating, annealing and forge furnaces. Also for general maintenance and patching.
B&W Kaolite 22	2200	Has the same properties as B&W Kaolite 20. Can be used for higher temperatures but not in reducing atmospheres.	

Send for your copy of B&W Bulletin R-35. It gives additional information on B&W's versatile refractory castables.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W

R561

(Continued from page 47)

886. Slitting
76-page handbook on multiple rotary slitting lines. Design, selection and operation of slitters. Specifications and capacity tables. *Yoder Co.*

887. Sodium
40-page booklet on handling metallic sodium gives typical sodium-using processes, equipment installation, recommendations for pumping and instrumentation. *U.S. Industrial Chemicals*

888. Soldering Fluxes
4-page bulletin on line of non-acid, self-cleaning fluxes. How they work. *Lake Chemical Co.*

889. Spectrochemical Analysis
28-page brochure on basic fundamentals of spectrochemical analysis. Methods, instruments, accessories described. Bibliography of reference material. *Jarrell-Ash Co.*

890. Spectrograph
24-page booklet on Echelle spectrographs. Advantages. Type of work produced. *Bausch & Lomb*

891. Spectrometer
8-page Bulletin 44 on direct reading spectrometers. Operation and construction. *Baird Associates*

892. Spring Steels
48-page booklet on selection of spring steel. How it is made, hardness values, physical property data. *Wallace Barnes Steel Div., Associated Spring Corp.*

893. Spring Wire
Selector guide for nickel alloy spring wire. Methods of heat treatment, processing of springs, stress relieving, annealing. *Techalloy Co.*

894. Stainless Castings
Bulletin on advantages of corrosion-resistant castings. *Ohio Steel Foundry*

895. Stainless Fasteners
New 24-page catalog 56-A lists sizes and types. 7000 items included. *Star Stainless Screw*

896. Stainless Steel
16-page booklet on Type 430 stainless gives physical properties and analysis, corrosion resistance, fabrication, application and care. *Washington Steel*

897. Stainless Steel
12-page bulletin on chromium-manganese austenitic steel. Effect of cold working, properties at elevated temperatures, corrosion resistance, magnetic permeability. *U.S. Steel Corp.*

898. Stainless Steel
32-page book on corrosion resistance of stainless steels. 18 tables on tests in acid, neutral and alkaline solutions. *International Nickel*

899. Stainless Steel
44-page book gives detailed information on use of stainless steel in the chemical industries. *Crucible Steel*

900. Stainless Steels
10-page booklet contains charts, graphs, data on cold rolled mechanical properties, elevated temperature properties, physical properties and corrosion resistance of chromium-nickel-manganese steels. *Allegheny Ludlum*

901. Steel
14-page manual on sizes and types of electric furnace steel. List of products equipped to roll from Byers melt. *A. M. Byers*

902. Steel Terms
32-page dictionary of terms used in the steel industry. 180 definitions. Equilibrium diagrams, tables and figures. *LaSalle Steel*

903. Stereoscopic Microscopes
32-page brochure describes Cycloptic microscope. Details of construction, accessories, models. *American Optical*

904. Strain Gages
8-page article on performance of SR-4 high temperature strain gages and how to apply them in "Testing Topics". *Baldwin-Lima-Hamilton*

905. Sub-Zero Treatment
12-page booklet on industrial chilling equipment for shrinking, testing and treating of metals. *Cincinnati Sub-Zero Products*

906. Surface Roughness
24-page booklet on standards for surface roughness, waviness and lay. 4 appendices contain examples and supplementary data. *Brush Electronics Co.*

907. Temperature Control
4-page bulletin on Pyrotac for automatic protection against excess temperature. Wiring is diagrammed. *Illinois Testing Laboratories, Inc.*

908. Temperature Indication
28-page bulletin on temperature indicating pigments. Ranges tested, directions for use, selection table. *Curtiss-Wright Corp., Research Div.*

909. Temperature Measuring
New bulletin 24-1 on selector switches for temperature measuring circuits. Types, construction and capacities. *Thermo Electric*

910. Temperature Measuring
Bulletins on Tempilstiks and Tempilaq describe products and tell how to use them. *Tempil® Corp.*

911. Tempilstiks
"Basic Guide to Ferrous Metallurgy", a plastic laminated wall chart in color. *Claud S. Gordon*

912. Tensile Tester
New 4-page booklet on impact wrench calibrator and tensile tester. Uses. Ultimate strength of standard screws. *Skidmore-Wilhelm Mfg. Co.*

913. Test Bars
18-page bulletin No. 168 on design of test bar patterns, production of test bars, testing procedures. *Federated Metals Div., American Smelting and Refining*

914. Testing Machines
12-page catalog on ten testers including hardness, ductility, tensile compression and transverse strength. *Detroit Testing Machine*

915. Testing Machines
Bulletin on Brinell hardness, ductility, compression, tensile, universal, transverse, hydrostatic proving instruments. *Steel City Testing Machines*

916. Testing Machines
24-page Bulletin 47 on complete line of Super "L" universal testing machines. Indicating systems, loading systems, diagrams of various machines. *Tinius Olsen Testing Machine*

917. Testing Machines
32-page booklet on hydraulic universal testing machines describes machines, accessories and calibrating service. *Riehle Testing Machines*

918. Textured Metal
16-page booklet on advantages and applications of textured metal. *Rigidized Metals*

919. Thermostats
4-page bulletin on bimetal thermostats. Temperature ranges, ratings, mountings, terminal arrangements. *Stevens Mfg. Co.*

920. Thickness Gage
Folder on pocket-size gage. How to use it. *Ferro Corp.*

921. Thickness Gages
32-page bulletin on beta gage describes sensing, positioning and control units, computing devices. *Tracerlab, Inc.*

FIRST CLASS
PERMIT No. 1595
(Sec. 34.9 P.L. & R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed In the United States

4c POSTAGE WILL BE PAID BY—

METAL PROGRESS
7301 Euclid Avenue
CLEVELAND 3, OHIO

BLAZING THE HEAT TREAT TRAIL WITH HOLCROFT



Obsolescence, unlike depreciation, is *not* a loss factor that can be estimated and provided for out of income. Yet, the operation of obsolete equipment does cost money . . . a cost that represents, more often than not, a loss far in excess of depreciation.

When you are buying new heat treat equipment, it is only good practice to buy with an eye to the future. By looking into such problems as atmospheres, automation, safety, mechanics, hydraulics and so on . . . today . . . you materially reduce tomorrow's obsolescence factor. Sometimes, existing furnaces can be redesigned with modern techniques and, as a result, can be geared to present production demands.

In any case, it is a good idea to talk over your problem with a Holcroft engineer. He has the technical know-how, the training and practical experience, to help you reduce early obsolescence in your plant. You'll find that Holcroft furnaces are built to answer today's problems—*and tomorrow's too.* Write for information.

6283

HOLCROFT AND COMPANY
6545 EPWORTH BOULEVARD • DETROIT 10, MICHIGAN
PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE

CHICAGO, ILL. • CLEVELAND, OHIO • HARTFORD, CONN. • HOUSTON, TEXAS • PHILA., PA.
CANADA: Walker Metal Products, Ltd., Windsor, Ontario

CMP

RESTRICTED SPECIFICATION COLD ROLLED STRIP STEEL



SIZE	8 x .045
ANALYSIS	1010
FINISH	#2 finish
HARDNESS	Non-Scalloping quality
THICKNESS TOLERANCE	± .0005 Incl. crown
WIDTH TOLERANCE	± .005
COIL SIZE	250# per inch of width
PACKAGING	Skidded





SIZE	12 x .032
ANALYSIS	1010
FINISH	#3 finish
HARDNESS	#4 Temper
THICKNESS TOLERANCE	± .0005 Incl. crown
WIDTH TOLERANCE	± .005
COIL SIZE	up to 200# per inch of width
PACKAGING	Paper inter-leaved— skidded and shrouded

Serves Typical Low Carbon End Use Requirements Such as these . .



Many times, by varying processing methods, CMP is able to develop properties in cold rolled strip steel which greatly facilitate production operations and/or give the product superior qualities without adding to end product cost. End result is lower costs through improved products or better assembly and improved yield.

We believe you will find it worthwhile to investigate the possibilities of CMP Restricted Specification Cold Rolled Strip Steel applied to your production.



SIZE	4 x .065
ANALYSIS	1010
FINISH	#2 finish
HARDNESS	#3 Temper
THICKNESS TOLERANCE	± .0005 Incl. crown
WIDTH TOLERANCE	± .005
COIL SIZE	Cut lengths
PACKAGING	Skidded

CMP PRODUCTS

Low Carbon, High Carbon — Annealed or Tempered, Stainless, Alloy, Electro Zinc Coated.

THE 3 IN 1 SOURCE FOR YOUR COLD ROLLED STRIP STEEL

Now there are three CMP plants with facilities for production of "Restricted Specification" cold rolled strip. Strategic locations at Youngstown, Indianapolis and Los Angeles, provide the security of 3 sources of supply plus the close working relationship which these local production centers make possible.

THE COLD METAL PRODUCTS CO.
GENERAL OFFICES: YOUNGSTOWN 1, OHIO
PLANTS: YOUNGSTOWN, INDIANAPOLIS AND LOS ANGELES
SALES OFFICES: NEW YORK - CLEVELAND - DETROIT - INDIANAPOLIS
CHICAGO - LOS ANGELES - SAN FRANCISCO

922. Tin
20-page bulletin on importance of tin to the American industry. Applications in aircraft, chemical, container, electrical, electronic equipment and others. *Malayan Tin Bureau*

923. Titanium
24-page fact file gives physical and mechanical properties, metallurgy, corrosion properties, machining, forming and welding data. *Mallory-Sharon Titanium*

924. Titanium and Zirconium
16-page bulletin, "The Hydrimet Process", on titanium and zirconium metals and hydrides, and other metallurgical hydrides. *Metal Hydrides*

925. Titanium Carbide
29-page pocket-sized book reviews methods of manufacture, properties, uses. Bibliography. *Titanium Alloy Mfg. Div.*

926. Tool Steel
Wall chart showing more than 300 varieties of tool steel with trade name of manufacturers. *Vulcan Crucible Steel*

927. Tool Steel
4-page bulletin on Ry-alloy, oil-hardening tool steel. Applications, advantages, heat treatment and forging practice. *J. T. Ryerson & Son*

928. Tool Steels
Bulletin on tool steels, hot work specialty steels, bar stock, billet, sand casting, drill rod, flat ground stock and tool bits. *Darwin & Milner, Inc.*

929. Tools and Dies
New 8-page brochure on eliminating cracking hazards in the manufacture of tools and dies. Design, how to make the tool, heat treatment and selecting the steel. *Carpenter Steel Co.*

930. Tool Steel Selector
Twist the dial of the 9-in. circular selector and read off the tool steel for your application. *Crucible Steel.*

931. Tube Bending
24-page catalog on plant processes and products. List of bending dies and data on minimum bend radii. *American Tube Bending Co.*

932. Tubing
Folder on small tubing for industry. *Precision Tube Co.*

933. Tukon Tester
12-page bulletin-328 on Tukon micro and macro hardness testers. *Wilson Mech. Inst.*

934. Ultrasonic Cleaning
Folder on Sonogen ultrasonic generator for metal cleaning. *Branson*

935. Ultrasonic Inspection
Ultrasonic Inspection Newsletter, No. 2, contains article on immersion inspection of wing spars for jet fighters. *Sperry Products*

936. Ultrasonic Machining
16-page bulletin lists typical machining operations, materials which may be machined ultrasonically, machine features and accessories. *Sheffield Corp.*

937. Ultrasonics
Data sheets on high-power ultrasonic generators for mass production and ultrasonic scrubber. *Acoustica Associates*

938. Vacuum Coating
8-page booklet on vacuum coating discusses principles, production, applications, economics, equipment. *NRC Equipment*

939. Vacuum Metallizing
Bulletin 780 gives uses and advantages of vacuum metallizing, materials and properties of vacuum metallized coatings, the process, equipment. *Stokes*

940. Vacuum Metals
File of data on vacuum-melted metals and their applications for bearings and the chemical industry. Development of the vacuum metals. *Vacuum Metals Corp.*

941. Vacuum Pumps
New 52-page catalog No. 425-B on high-vacuum pumps contains formulas and tabular data. *Kinney Mfg.*

942. Vacuum Pumps
16-page booklet on maintenance of vacuum pumps. *Stokes*

943. Vacuum Valves
New 32-page manual on high-vacuum valves. Requirements for high vacuum service, sizes, materials. *NRC Equipment*

944. Welder
Specifications and construction details for 300, 400 and 500 amp. combination a.c. and d.c. welders. *Lincoln Electric Co.*

945. Welding
24-page booklet on electric resistance welding of butane gas containers. Procedures, metallurgical advantages. *Sciaky Bros, Inc.*

946. Welding
Three bulletins, F-1060, F-1076, and F-1066, on Unionarc welding. Results of production line tests, applications and weld quality are discussed. *Linde Co.*

947. Welding Electrodes
84-page pocket-size booklet describes characteristics, coating, sizes of various electrodes and compares them with standard designations and other electrode brand names. *Harnischfeger*

948. Welding Electrodes
50-page book on electrodes of stainless, mild and high-tensile steels, cast iron, nonferrous alloys, low-hydrogen and hardfacing compositions. *Air Reduction*

949. Welding Electrodes
4-page folder on physical properties as welded, analysis, tensile strength, elongation, hardness and uses of gas welding rods, bare electrodes, welding wire and metal spray wire. *Page Steel & Wire Div., American Chain & Cable Co.*

950. Welding Equipment
Catalog on Cadweld process and arc-welding accessories. *Erico Products*

951. Wire Cloth
New 94-page catalog on line of industrial wire cloth, screen and wire cloth products. Types, sizes, applications. Metals and alloys used, stainless compositions, corrosion tables. *Cambridge Wire Cloth*

952. X-Ray
12-page bulletin on gamma radiography tells how to select the source, equipment, techniques and fundamentals of gamma radiation. *Picker X-Ray*

953. X-Ray Films
6-page folder on industrial X-ray films and processing chemicals. Exposure characteristics. Selection of best film for each job. *Ansco*

954. X-Ray Inspection
Reprint on methods used for automatic X-ray inspection of subminiature electron tubes. *Philips Electronics*

955. Zirconium
12-page booklet on uses, properties and methods of production of zirconium and hafnium. *U.S. Industrial Chemicals Co.*

956. Zirconium Oxide
Product list gives chemical analysis, description and uses of four types of zirconium oxide. *Zirconium Corp. of America*

957. Zirconium
7-page bibliography on properties of zirconium and its alloys. *Columbia-National Corp.*

September, 1957

615	642	669	696	723	750	777	804	831	858	885	912	939
616	643	670	697	724	751	778	805	832	859	886	913	940
617	644	671	698	725	752	779	806	833	860	887	914	941
618	645	672	699	726	753	780	807	834	861	888	915	942
619	646	673	700	727	754	781	808	835	862	889	916	943
620	647	674	701	728	755	782	809	836	863	890	917	944
621	648	675	702	729	756	783	810	837	864	891	918	945
622	649	676	703	730	757	784	811	838	865	892	919	946
623	650	677	704	731	758	785	812	839	866	893	920	947
624	651	678	705	732	759	786	813	840	867	894	921	948
625	652	679	706	733	760	787	814	841	868	895	922	949
626	653	680	707	734	761	788	815	842	869	896	923	950
627	654	681	708	735	762	789	816	843	870	897	924	951
628	655	682	709	736	763	790	817	844	871	898	925	952
629	656	683	710	737	764	791	818	845	872	899	926	953
630	657	684	711	738	765	792	819	846	873	900	927	954
631	658	685	712	739	766	793	820	847	874	901	928	955
632	659	686	713	740	767	794	821	848	875	902	929	956
633	660	687	714	741	768	795	822	849	876	903	930	957
634	661	688	715	742	769	796	823	850	877	904	931	
635	662	689	716	743	770	797	824	851	878	905	932	
636	663	690	717	744	771	798	825	852	879	906	933	
637	664	691	718	745	772	799	826	853	880	907	934	
638	665	692	719	746	773	800	827	854	881	908	935	
639	666	693	720	747	774	801	828	855	882	909	936	
640	667	694	721	748	775	802	829	856	883	910	937	
641	668	695	722	749	776	803	830	857	884	911	938	

METAL PROGRESS,

7301 Euclid Avenue, Cleveland 3, Ohio

Please have literature circled at the left sent to me.

Name _____

Title _____

Company _____

Address _____

City and State _____

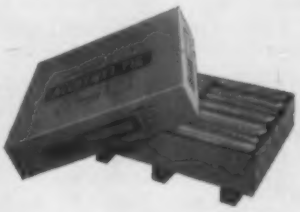
Postcard must be mailed prior to Dec. 1, 1957. Students should write direct to manufacturers.



HOW MUCH NICKEL IN A CHARGING BOX FULL OF SCRAP?

Even the best guess is never a sure thing. Never as sure as using Alloymet Nickel Alloy Pig. Comes to you in freight-saving all-fiberboard carton with its own pallets — weight and certified analysis right on the side. The whole carton of 26 pigs — about 1300 pounds — goes right into the furnace as is.

Check with us. See how using Alloymet Pig works out in your steelmaking operation.



ALLOY METAL PRODUCTS, Inc.
PHONE 6-2561 • TELETYPE DV 588
(FORMERLY A DIVISION OF **ALTER COMPANY**)
ROCKINGHAM ROAD
DAVENPORT, IOWA

World's largest producer of secondary nickel alloys of certified analysis



Henry Seeboth, President of Larpen Industries, and Chief Radiographer Gilbert Thornton position a 160 kv.p. portable x-ray unit under an airplane wing in preparation for inspection of the attach joint.

Du Pont Technical Representative Joe Vokoun "is trained in the problems of our business, and has always given his time and experience when needed," says Mr. Seeboth. Here, Mr. Vokoun, Mr. Seeboth (seated) and Chief Radiographer Thornton discuss a radiograph.

"We cut this client's inspection cost in half...
with Du Pont Type 506 X-ray Film"

says Mr. Henry Seeboth, President of Larpen Industries, Inc., Milwaukee, Wisc. Larpen checks a wide range of products with gamma and x-ray inspection.

Recently a large industrial firm called on Larpen to inspect the wing attach joint on their private plane during a 4000-hour check-up. It was decided to x-ray the attach joint without tearing down the whole wing section. Du Pont Type 506 film was picked for the job.

"The results of the test were approved by the CAA, and, through the use of x-ray, we cut our client's cost by 50%.

"Wide exposure latitude," explains Mr. Seeboth, "is essential in our business as we are not working with a standard product. When we calculate an exposure time using Du Pont film, we know the estimate can be off as much as 20% and the results will still be of the necessary critical quality. Without this excellent latitude, we would have to waste man-hours and material before establishing a correct exposure."

Mr. Seeboth concludes, "When you consider that this film is rugged enough to withstand handling under adverse field conditions and will not curl when subjected to high temperatures, you can see why we've been using Du Pont x-ray film since we first tried it in 1949."

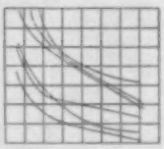
For more information about Du Pont industrial x-ray films, contact the nearest Du Pont sales office, or write Du Pont, Photo Products Dept., 2420-2 Nemours Building, Wilmington 98, Delaware. In Canada: Du Pont Company of Canada (1956), Limited, Toronto.

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living
...through Chemistry

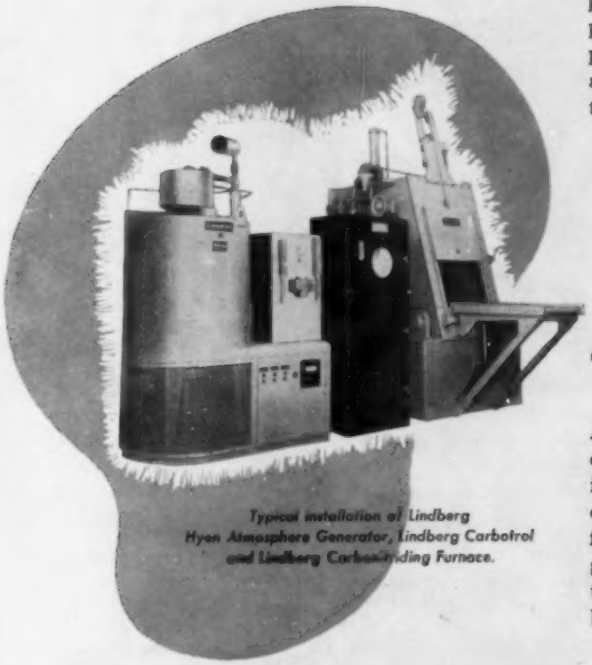
Du Pont Industrial X-ray Products
Films..."Patterson" Screens...Chemicals

What every good metal man should know about CARBONITRIDING

First of all, it is a good idea to know what equipment will do the best carbonitriding job for your specific requirement. And the best way to find this out is to talk over your problems with the people who have consistently developed the methods and equipment for better, more dependable, more economical carbonitriding results. That would be Lindberg.



Let's look at the record. Lindberg's contributions to carbonitriding and carburizing go far beyond just the building of furnaces to do it. It covers the development of controlled atmosphere generators, the creation of dew point equilibrium curves to establish proper atmosphere values for type of steel and temperatures involved and the exclusive Lindberg Carbotrol to maintain these values automatically in production.



Typical installation of Lindberg Hyen Atmosphere Generator, Lindberg Carbotrol and Lindberg Carbonitriding Furnace.



Then there is the invention of the "dimple" vertical radiant tube which gave new efficiency and economy to fuel-fired atmosphere furnaces. Lindberg's exclusive CORRTHERM electric heating element made practical the use of electricity in atmosphere furnaces.



Add to this our record over the years of building a broad variety of carbonitriding and carburizing furnaces, big ones, small ones, manuals, automatics, fuel-fired, electric, and it seems it's just good common sense to bring your heat treating problems to us. Just get in touch with the Lindberg Field Representative in your locality or write:

LINDBERG ENGINEERING COMPANY

2450 West Hubbard St., Chicago 12, Illinois

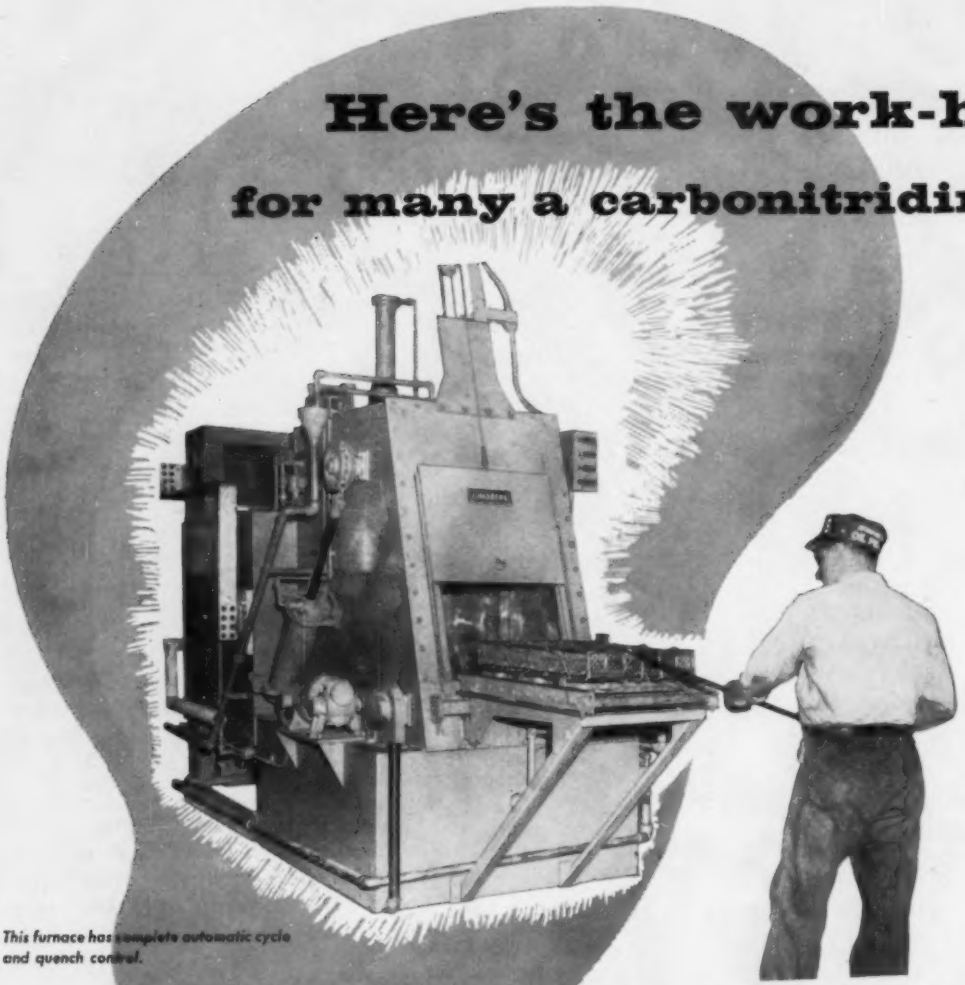
Los Angeles Plant: 11937 S. Regentview Ave., at Downey, California.



heat for industry

Here's the work-horse

for many a carbonitriding job



This furnace has complete automatic cycle and quench control.

This is the most widely-used carbonitriding furnace of all. Day in and day out production of tons and tons of work has proved this furnace's ability to increase production quality and volume and reduce costs. It is a versatile furnace, too, not only for carbonitriding but for other uses, carburizing, annealing, carbon restoration and many hardening applications.

This type of furnace is available for both manual and automatic operation. It can be equipped either with Lindberg's efficient new vertical radiant tubes for fuel-firing or for electric heating with Lindberg's revolutionary new CORRTHERM element.

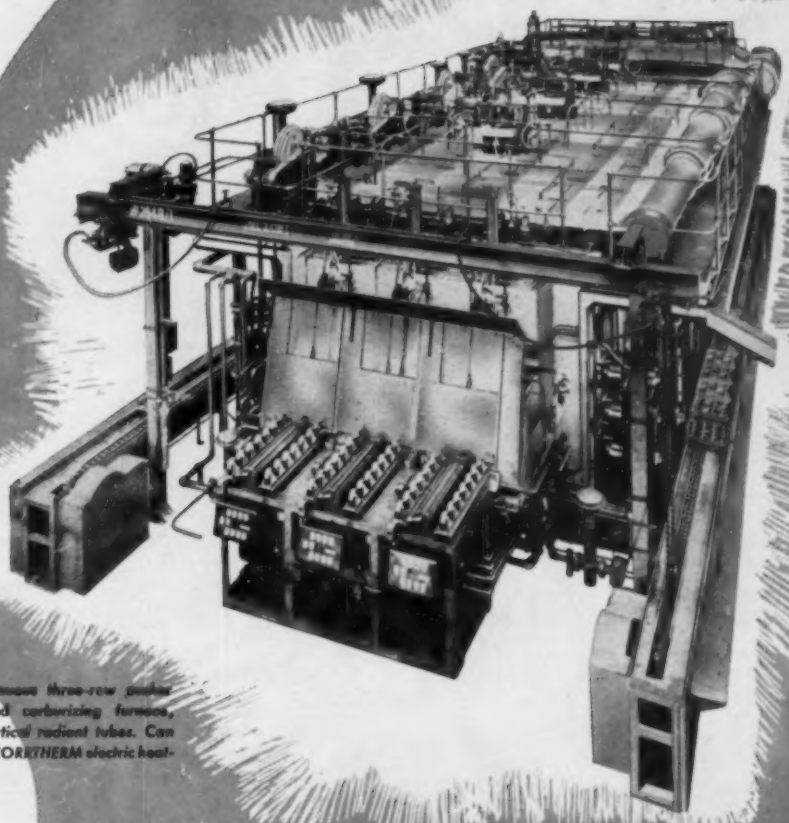
Versatile as this furnace is, we don't claim it is the best solution to *every* carbonitriding problem. But, whatever your need may be, talk it over with Lindberg. Our engineers, as they have done in so many instances, will recommend a sound answer—design it, build it, even field-install it if you wish. Just get in touch with the Lindberg plant or the Lindberg Field Representative in your locality. Lindberg Engineering Company, 2450 West Hubbard St., Chicago 12, Illinois. Los Angeles Plant: 11937 S. Regentview Ave., at Downey, California.



LINDBERG

heat for industry

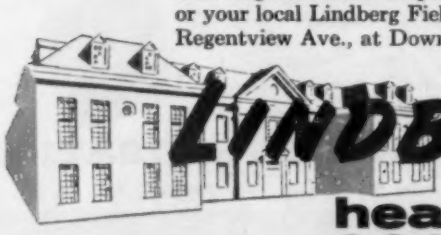
We put the Big Heat on with this one!



A Lindberg continuous three-row pusher carbonitriding and carburizing furnace, gas-fired with vertical radiant tubes. Can also be built with CORETHERM electric heating elements.

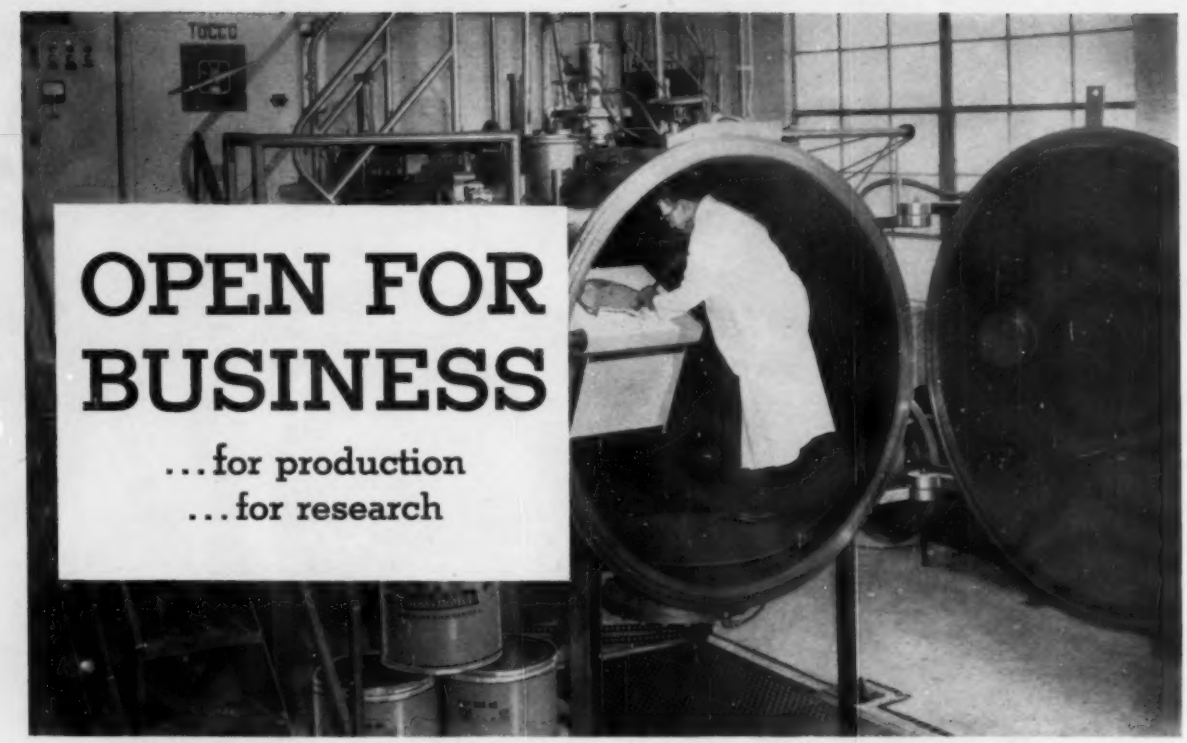
If your carbonitriding or carburizing problem is a big one, better talk it over with Lindberg. The broad experience of our engineering staff in the development of methods and equipment for every heat treating function offers a pretty sure promise of the most practical answer to it. Particularly where field installation is advisable our combination of engineering know-how and sound installation experience is especially valuable to you.

Whether your requirement will call for the installation of a big baby like the one shown above or a complete heat treating department of smaller units, Lindberg will handle the job all the way. We specialize in "turn-key" installations, covering everything from design and engineering to the finished ready-to-go-to-work job complete with all the construction needed to fit the heat treating equipment into your production processes. Pass your problem to Lindberg. Get in touch with Lindberg Industrial Corporation, 2321 West Hubbard Street, Chicago 12, Illinois, or your local Lindberg Field Representative. Los Angeles Plant: 11937 S. Regentview Ave., at Downey, California.



LINDBERG

heat for industry



OPEN FOR BUSINESS

...for production
...for research

ULTRAMET ALLOYS are processed at less than 10 microns of vacuum, in this latest design vacuum melting furnace — fully equipped for refining and manipulation of the charge under exact time and temperature controls. Result: super-clean, super-strong metals offering you greater tensile strength, ductility and wear life . . . higher electrical and magnetic properties.

Cannon-Muskegon offers complete vacuum-melting facilities for ferrous, nickel- and cobalt-base alloys

NOW AVAILABLE: stainless, tool and die, magnetic steels—high-temperature, corrosion-resistant, low expansion alloys — bearing steels, and alloys for electrical and electronic applications plus special steels.

We offer industry:

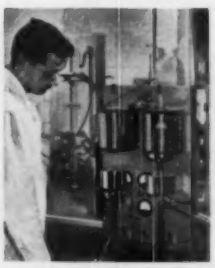
Materials for remelt and processing— in pounds or tons — under vacuum, conventional air-melting or inert gas processes.

Casting development, including research and experimental facilities for investment, shell mold, dry sand and permanent mold castings.

Ingots, billets and a variety of cast forms — for rolling, forging, extruding or machining.



X-Ray fluorescence spectrometer—the most modern means for rapid and accurate analysis of major elements in alloys — just one of a series of regular evaluations that maintain highest quality control standards.



Precise carbon analysis is another UltraMet test for chemical quality. Additionally, tensile properties, creep tests, Rockwell hardness, bent wire and other tests safeguard perfection throughout production.



MasterMet alloys are produced by air-melting in modern high-frequency furnaces. The chemical analysis of each melt is certified to your specifications — exactly produced to compensate for melting losses.

For full particulars, write for our new bulletin on Vacuum Melting and Air Melting facilities and alloys . . . plus details on new "light" specs on Armco 17-4PH.



MASTERMET CERTIFIED ALLOYS

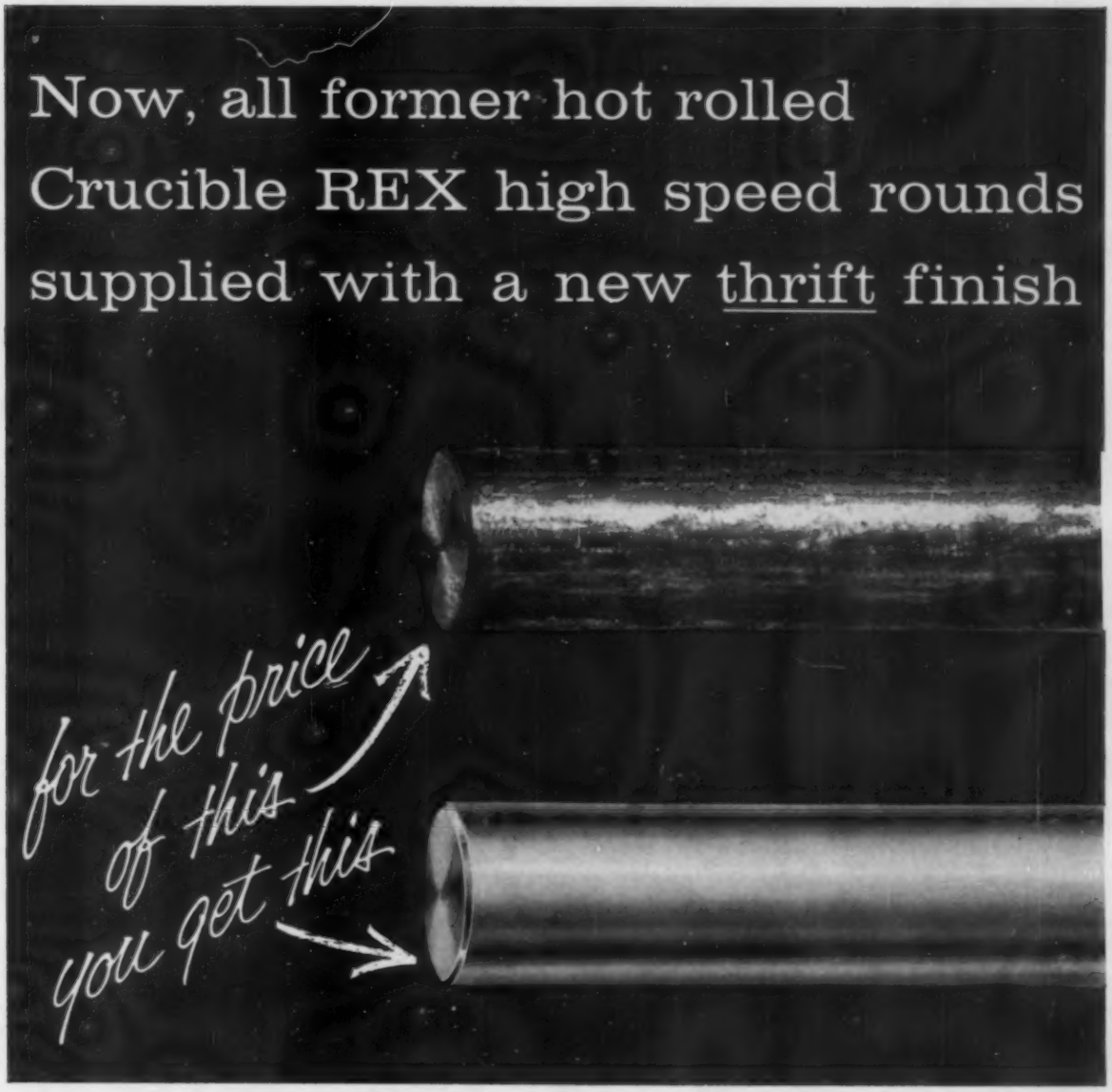
ULTRAMET VACUUM-MELTED ALLOYS

CANNON-MUSKEGON CORPORATION

2879 Lincoln Avenue • Muskegon, Michigan, U.S.A.

METALLURGICAL SPECIALISTS

Now, all former hot rolled Crucible REX high speed rounds supplied with a new thrift finish



Here's a revolutionary, new Crucible policy designed to provide an improved product—save time and processing costs. Now, Crucible furnishes all REX® high speed rounds from ⅝" up with a machined surface, close to size and free from decarburization. All bars from ¼" to ⅝" round are supplied cold finished.

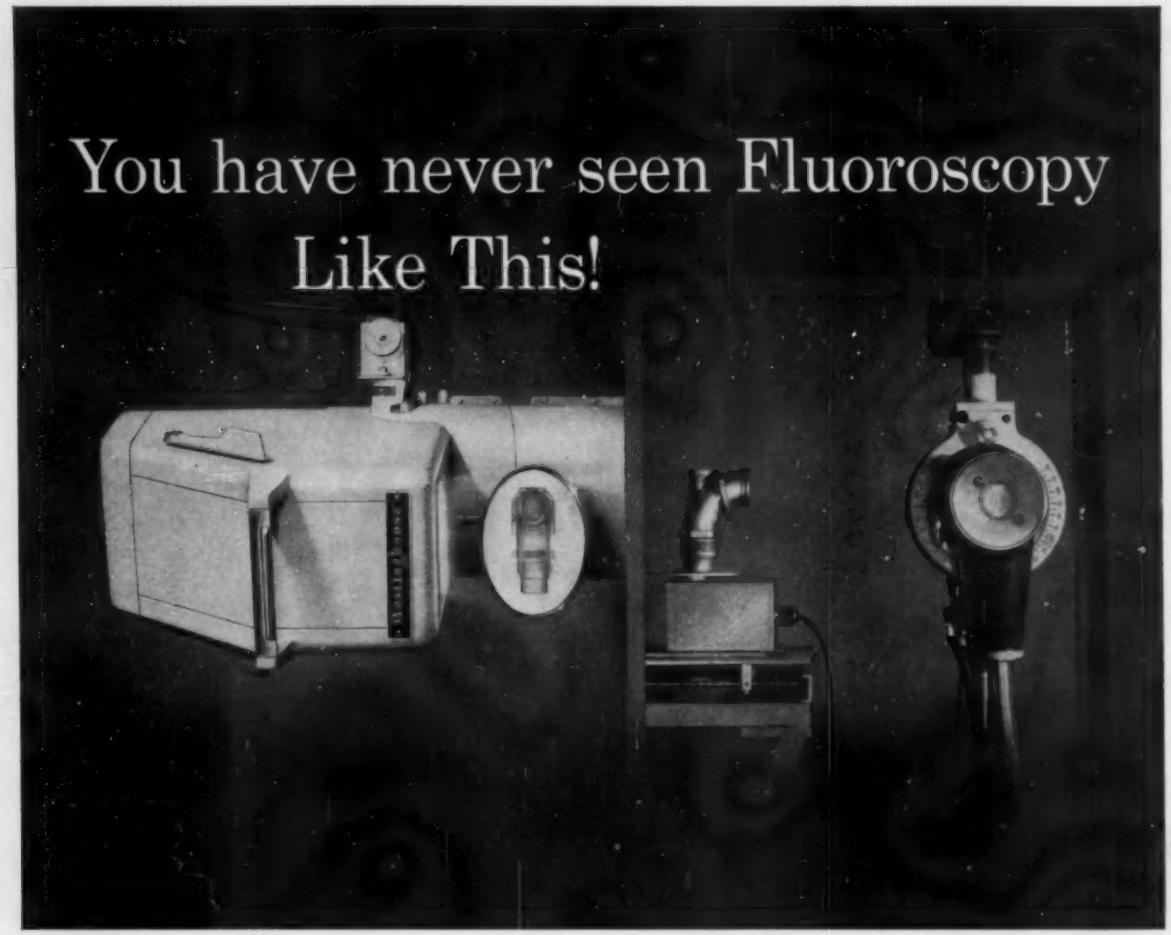
This new *thrift* finish means important savings to you – whether you've been paying extra for decarburization and stock removal, or grinding or rough turning rounds in your own shop. Of course, where extremely close tolerances are demanded, precise centerless grinding is still available at a small extra.

It's another Crucible "first" that offers you substantially more for your high speed steel dollar. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.



FLUOREX Penetrates Thicker Sections . . . Shows Better Detail!

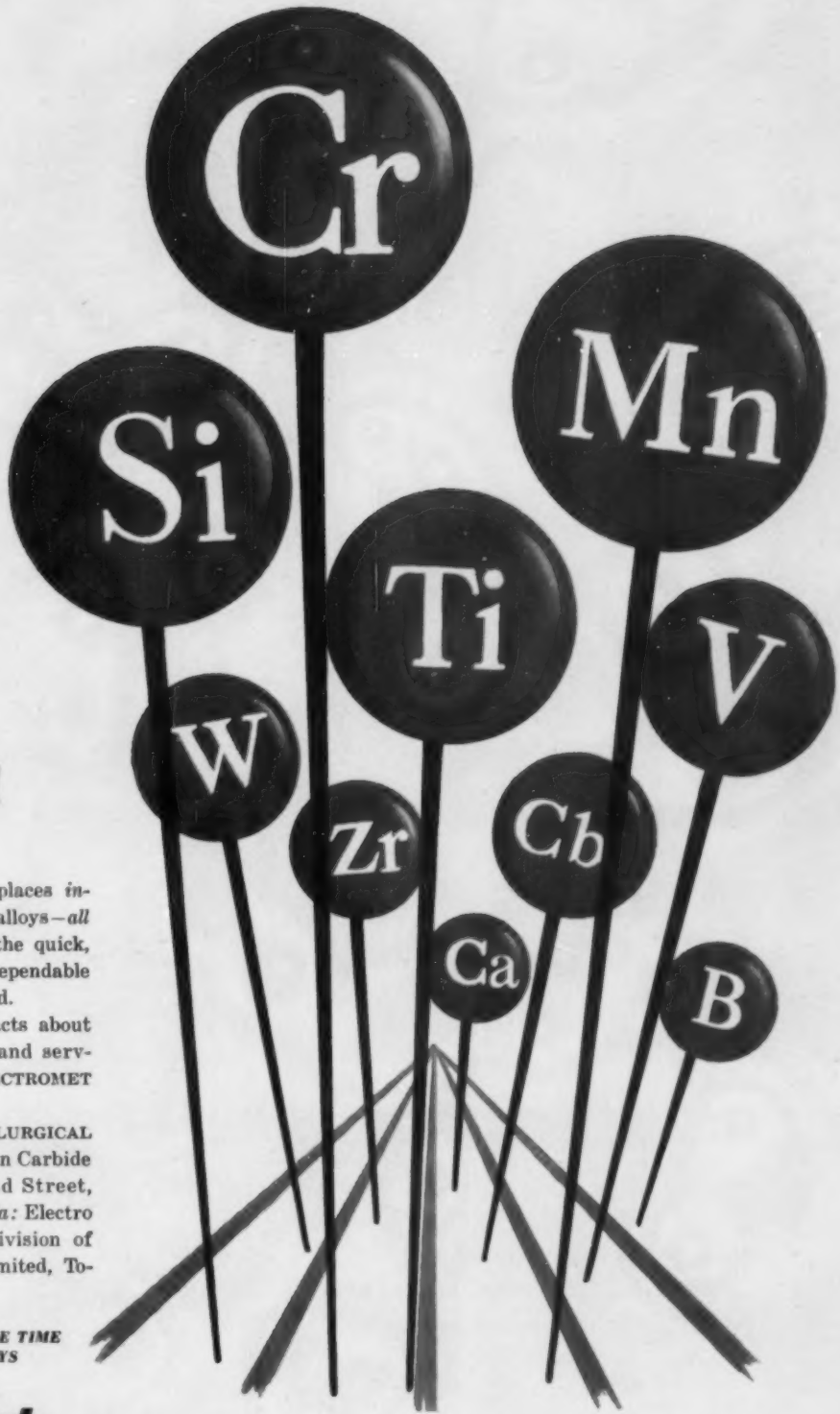
Now you can "see" through thicker, heavier castings, welds and assemblies with unsurpassed detail, definition and resolution. The Fluorex® Image Intensifier, a product of Westinghouse research and engineering, assures rapid, accurate fluoroscopic inspection; lets you see *more, faster*. Other advantages are daylight viewing (because image is so bright), and a field no larger than the eye can view comfortably. Fluorex can be quickly adapted to your existing X-ray inspection equipment.

Whatever your X-ray inspection problem may be, our staff of Industrial X-ray Engineers can help you solve it with Westinghouse fluoroscopic or radiographic equipment. Write today for complete information: Westinghouse Electric Corporation, X-ray Department, 2519 Wilkens Avenue, Baltimore 3, Maryland. J-08352

YOU CAN BE SURE...IF IT'S

Westinghouse

INDUSTRIAL X-RAY
Westinghouse Electric Corp.
X-RAY DEPARTMENT
2519 Wilkens Avenue
Baltimore 3, Maryland



YOU NAME IT!

A call to ELECTROMET places *instantly* at your disposal the alloys—*all* the alloys—you need. It's the quick, convenient way to assure dependable supplies of *whatever* you need.

Get all the important facts about ELECTROMET's products and services. Get our Catalog: "ELECTROMET Ferro-Alloys and Metals."

Write ELECTRO METALLURGICAL COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Electro Metallurgical Company, Division of Union Carbide Canada Limited, Toronto.

METALS DO MORE ALL THE TIME ...THANKS TO ALLOYS

Electromet
FERRO-ALLOYS AND METALS

UNION CARBIDE

WE HAVE IT! More than 100 different alloys are stocked and ready for immediate delivery at ELECTROMET. Alloys of the major elements including: Chromium, Manganese, Silicon, Titanium, Vanadium, Tungsten, Boron, Calcium, Columbium, Zirconium.

The terms "Electromet" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.



STAINLESS STEEL
produced the way *you* want it by Carlson

Only at Carlson can you buy so many grades of stainless steel in the wide variety of shapes and sizes illustrated here. We regularly process such complete bill-of-material orders. Trained Carlson men, with years of experience and practical knowledge, are determined to give you the best and most efficient service possible.

When you need stainless plate... Carlson gives you what you want when you want it!

Write for CARLSON'S WEEKLY STOCK LIST . . . your guide to what's available in high-quality stainless steel.

G.O.CARLSON *Inc.*

Stainless Steels Exclusively

128 Marshalton Road
Thorndale, Pennsylvania

District Sales Offices in Principal Cities

STAINLESS STEEL PLATE . . . rolled to almost any size or thickness, 3/16" and heavier, to meet your individual needs—whether rectangles, circles or special patterns. Substantial tonnage in Types 302, 304, 304-L, 309, 309-S, 310, 316, 316-L, 317, 317-L, 321, 347, 348, 405, 410, 430 and 502-½% Mo. is available for prompt delivery. In addition, two precipitation-hardening grades, Types 17-4 PH* and 17-7 PH* are now in production.

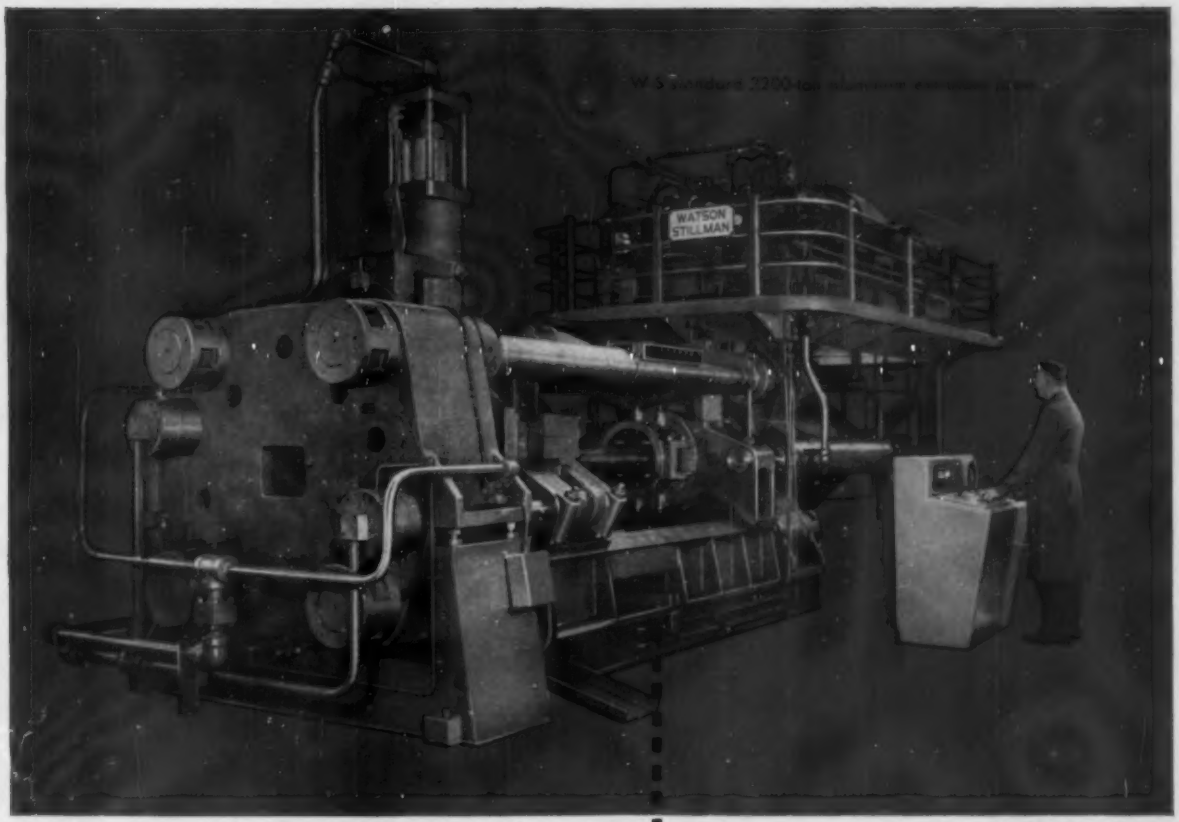
STAINLESS STEEL HEADS . . . in Types 304, 304-L, 316 and 316-L are available from stock in ASME and Standard specifications (10" to 72" diameter). A large assortment of dies is available for pressing other types of heads and special sizes can be spun where practical.

STAINLESS STEEL FORGINGS and SPECIAL PATTERNS . . . including tube sheets, flanges, circles, rings, sketch plates and other specialties can be produced to specification on our versatile equipment.

Also STAINLESS STEEL BARS AND SHEETS (No. 1 Finish).

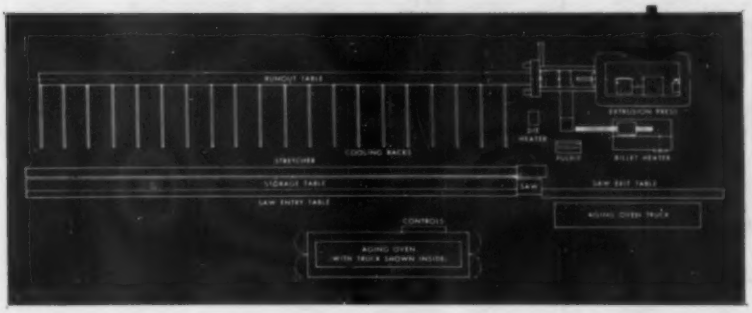
*Trade mark of ARMCO STEEL CORPORATION

PLATES • PLATE PRODUCTS • HEADS • RINGS • CIRCLES • FLANGES • FORGINGS • BARS and SHEETS (No. 1 Finish)



There's a W-S press with years-ahead design

—to fit your extrusion plans



You get the advanced features, speeds and flexibility you need to meet *today's* as well as *tomorrow's* production plans...when you choose from the Watson-Stillman line of aluminum extrusion presses.

Records of increased production attest to the dependability of W-S presses. Faster cycling, smooth operation and solid construction make these presses the leading profit producers in the industry. Standard sizes range in capacities from 600 to 5,000 tons in self-contained oil-operated or water-accumulator types arranged for conventional or special operations.

Hydraulic Stretchers are also available—in 15, 25, 35, 60 and 100 ton capacities in either de-twisting or straight pull designs. And, in addition, Watson-Stillman provides a complete engineering service, from press design to final installation and operation.

For full details, send for your FREE copy of *new* bulletin 340-C.

WS-36

WATSON-STILLMAN PRESS DIVISION
FARREL-BIRMINGHAM COMPANY, INC.
160 Aldene Road, Roselle, N. J.
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Manufactured and sold in Canada by: Canadian Vickers Ltd.

WATSON-STILLMAN



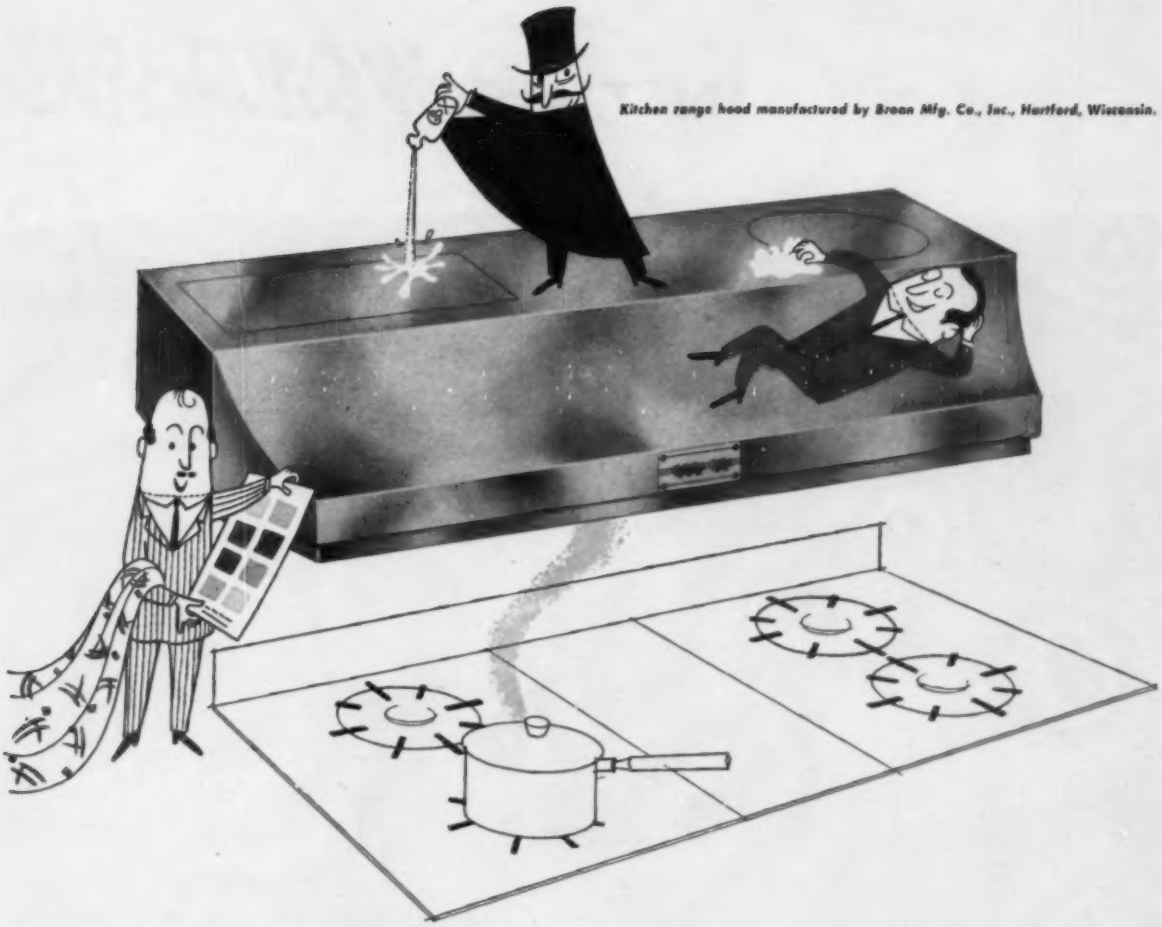
WYMAN-GORDON COMPANY

Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

WORCESTER 1, MASSACHUSETTS

HARVEY, ILLINOIS • DETROIT, MICHIGAN



Kitchen range hood manufactured by Broan Mfg. Co., Inc., Hartford, Wisconsin.

Blends with all colors-resists acids–easy to clean

You get all 3 with products made of Crucible stainless

They're 3 selling advantages that put any product made of Crucible stainless steel way out ahead of the competition. This stainless steel exhaust hood, for example, cleans faster than any other kind. It has an eye-catching, smooth, shiny surface that withstands almost anything—even acids. And stainless steel's glitter-grey look blends with any color—anywhere. In fact, Crucible stainless enhances other colors by reflecting them. (Think how dealer inventories drop when 1 color satisfies all needs.) And think how far ahead your product would be with these selling advantages of Crucible stainless steel. To find out more about Crucible stainless, write for the handy Crucible Stainless Steel Selector. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

IN THIS *WONDERFUL*



Fabrication . . . The purchase and operation of metalworking machinery, equipment and supplies involves an engineering knowledge of metals. Engineering knowledge of metalworking, end product requirements, and metals, involve ME Factors that influence specifying and purchasing decisions. Only Metal Progress concentrates on providing engineering information for 29,058 Metals Engineers.

Design Application . . . ME Factors govern specifications for metal products. From thousands of sources and specifications for a tremendous variety of metals, ONE selection is most efficient, most economical. Extensive engineering knowledge of metals and processes provides the correct answer. Metal Progress and the American Society for Metals provide annually more than 100 million pages of Metals Engineering information.

WORLD OF METALS

ME Factors

mean everything!



Only metal could give us this wonderful era of tomorrow. Only metal could give us the tough, durable tools of manufacture...the shimmering, gleaming conveniences of comfortable leisure...the new, potent weapons of national defense. Only *metal* could serve so well.

And metal is made our most effective resource by strict adherence to ME Factors...*Metals Engineering Factors* that govern each step of production, processing, fabrication, testing and design application.

Today, the Metals Engineers and the Metallurgists...*the experts who know ME Factors*...are bound together through membership in the American Society fof Metals and through readership of Metal Progress...their Society's brilliantly-edited, Eastman-Researched monthly magazine of metals engineering. 29,058 metals engineers eagerly seek the benefits of over 100 million pages of engineering information published annually by ASM...vital information, essential to the correct use and engineering application of ME Factors.

If you sell the metal industry, the success of your products may be determined by ME Factors. Do you know these factors? Are you familiar with them? Why not check them over with an ASM staff engineer...he will be happy to provide an ME Factor Chart that applies to your products. Phone or write your ASM district manager for this free service.

TYPICAL PRODUCTS INFLUENCED BY ME FACTORS

Purchase and use of products such as these depend upon knowledge of ME Factors . . . *Metals Engineering Factors*. Only Metal Progress and the American Society for Metals concentrate on engineering information involving metals. Because Metal Progress is the one metals engineering magazine, it is basic to your business of selling the metal industry.

Steels (Plain and Alloy)	Castings	Furnaces and Parts	Brazing and Soldering
Stainless Steels	Powder Metals and Parts	Induction Heaters	Fasteners
Tool Steels	Precision Castings	Special Heating Equipment	Degreasing Equipment
High Temperature Alloys	Stampings	Quenching Fluids, Equipment	Electroplating Equipment
Light Metals and Alloys	Weldments	Atmosphere Preparation	Finishes
Heavy Nonferrous Metals and Alloys	Tubing and Other Mill Shapes	Salts	Rust Preventatives
Mill Equipment	Forgings	Supplies	Buffers and Polishers
Ferro Alloys	Extrusions	Pyrometers	Equipment for Purification of Solutions
Refractories	Tool Steels and Tool Materials	Indicators and Recorders	Mechanical Testing Equipment
Melting Furnaces	Cut-Off Equipment	Gas Samplers and Analyzers	Microscopes and Attachments
Die Casting Machines	Presses and Brakes	Automatic Flow and Pressure Controls	Hardness Testers
Forging Equipment	Machine Tools	Gas Welding and Cutting	Nondestructive Testing Equipment
Foundry Equipment and Processes	Coolants and Lubricants	Electrical Processes	Gages and Comparators

CLEVELAND 3: *W. J. Hilty, District Manager • 7301 Euclid Ave. • UTah 1-0200*
CHICAGO 4: *Victor D. Spatafora, District Manager • 53 West Jackson Blvd. • WAbash 2-7822*
DETROIT 21: *Don J. Walter, District Manager • 20050 Livernois St. • UNiversity 4-3861*
NEW YORK 17: *John B. Verrier, Jr., Regional Manager • Fred Stanley, District Manager • 342 Madison Ave. • OXford 7-2667*

METAL PROGRESS

"The Magazine of Metals Engineering"
Published by the American Society for Metals
7301 EUCLID AVENUE • CLEVELAND 3, OHIO

What's New in Steel...

ALUMINUM, PLASTICS AND MACHINERY FROM RYERSON

Information on stocks and services and other recent developments of interest to men concerned with cost-cutting opportunities, sources of supply and availability of steel, aluminum, plastics and metal-working machinery.

STRUCTURALS—Greatly improved structural stocks after many months of short supply is the biggest news at Ryerson plants. Even many of the heavier sections for which demand is strongest are now available for immediate shipment.

PLATES—Stocks of heavy carbon steel plates are now much improved—and light plates continue in excellent supply. Moreover, these plates are produced to a new specification with more closely controlled chemical analysis resulting in better forming, welding and machining qualities.

HOT ROLLED CARBON STEEL BARS, including bar-size (light-structural) shapes—Huge Ryerson stocks of practically every size and shape now ensure immediate shipment of your company's requirements. Angles, channels and tees in bar sizes (below 3") are in equally good supply.

PRE-PAINTED SHEETS AND STRIP—To save you costly finishing operations Ryerson can now furnish steel sheets or slit coils pre-finished with durable baked enamel. Steel can be finished one side or two, in any plain color or in your choice of several patterns—and users report that the painted finish stands up under cutting and forming operations without cracking or peeling. Unusually large sheet and coil stocks plus unequalled processing facilities round out Ryerson sheet and strip service.

NEW ALLOY PLATE STOCKS—Due in July, midwestern stocks of A8620 plate steel in 1/2" to 6" thicknesses. This case hardening steel, ideal for rings, discs, gears, etc., can be furnished in flats or flame-cut blanks. These stocks supplement eastern stocks of E8615 plates. Also coming this summer: Eastern stocks of 4140 alloy plate.

STAINLESS, CARBON STEEL TUBING AND COLD FINISHED BARS—All types and sizes available in the nation's largest stocks—including nickel-bearing stainless, supply of which was, until recently, affected by nickel shortage.

ALUMINUM FOR ARCHITECTURAL USE NEWLY AVAILABLE—Ryerson plants supplying aluminum can now furnish Type 5005 in sheets and coils. This type is especially suitable for architectural use because it closely matches the finish of architectural aluminum extrusions—and it takes clear or color anodizing very satisfactorily.

PVC PLASTIC PIPE IN LARGE DIAMETERS—8'' and 10'' pipe in both schedule 40 and 80 have been added to growing Ryerson stocks of the remarkably anti-corrosive plastic—Ryertex-Omicron polyvinyl chloride. Valves and fittings of PVC for these big sizes also available.

QUICK MACHINERY DELIVERIES FROM STOCK—Machinery demand continues strong but improved production facilities have resulted in quicker deliveries of many types of metal-fabricating machinery available from Ryerson. This is true of equipment produced by Kling, Dreis & Krump, Bertsch, Wysong & Miles and several others. Some of the more popular models are even available from stock.



JOSEPH T. RYERSON & SON, INC. PLANTS: NEW YORK • BOSTON • WALLINGFORD, CONN. PHILADELPHIA • CHARLOTTE • CINCINNATI • CLEVELAND • DETROIT • PITTSBURGH • BUFFALO CHICAGO • MILWAUKEE • ST. LOUIS • LOS ANGELES • SAN FRANCISCO • SPOKANE • SEATTLE

Metal Progress
Volume 72, No. 3 September 1957

Extrusion of a Complex Shape Through a Round Die

*By WILLIAM E. RAY**

A long, straight control rod of Y-shaped cross section for a nuclear reactor is made by canning flat cermet compacts, assembling them with appropriate inserts of soft steel to fill a sealed sheath, hot extruding the combination, and then dissolving the soft steel inserts in acid, leaving behind the required stainless-clad rod.
(T11j, 17-7, F24; SS, Eu, 8-16)

IT IS DOUBTLESS well known by now that the energy produced in a nuclear reactor comes from what has been called a chain reaction. Of course the heat from a glowing charcoal grill also comes from a chain reaction – a chemical reaction. But in the nuclear reactor the reaction is physical, the links in the chain being free neutrons, uncharged particles which are torn away during the splitting of an atomic nucleus. These neutrons quickly hit another "fuel" atom nearby, splitting it and liberating more free neutrons, and so on and on. This nuclear chain reaction converts a little of the mass into an enormous amount of energy.

This energy must be carried away by suitable coolants – gas or liquid – else the reactor would melt. The uranium fuel must be protected from corrosion by the coolant and the coolant must be protected from contamination by the uranium. This means that the uranium (either as metal in an alloy, in a dispersion, or in a chemical compound) must be sheathed in corrosion resisting metal. Consequently we find that the "fuel elements" in a reactor core are usually thin plates of enriched uranium, clad with aluminum, zirconium or stainless steel, depending on operating

*Metallurgical Engineer, Knolls Atomic Power Laboratory, General Electric Co., Schenectady, N.Y.

temperature and coolant, and nested in square or hexagonal arrays so the cooling medium can circulate freely and uniformly throughout.

Other essential members are "control rods" – sheathed rods of metal or compound which is a "poison", a material which absorbs neutrons readily, capturing them *without* any resulting fission. These rods are the safety valves; when the nuclear reaction speeds up to a point where the resulting rise in temperature is likely to cause trouble, the control rods are pushed down into the reactor core just enough to absorb the excess neutrons and regulate the heat evolution at a steady output. To stop the chain reaction the control rods are fully inserted, thus capturing so many neutrons that the process no longer is self-supporting.

The following article will summarize methods of making clad control rods like the one shown in Fig. 1. This has a Y cross section to fit neatly between fuel-element assemblies of hexagonal cross section. Temperature and coolant were such that this rod should be clad with stainless steel. The hub at the top end of Fig. 1 is integral; it connects the control rod with its driving mechanism. When the reactor is in operation, only a little of the bottom end of the rod is in the region of high neutron flux.

Certain considerations which need not be elaborated here in detail indicated that the core of the control rod should be a dispersion of europium oxide in stainless steel and the cladding should be of stabilized 18-8 stainless steel. Europium was chosen because it has high neutron capture cross-section which in turn creates heavier isotopes of the same metal also with high neutron capture cross section and of long life. Thus the effectiveness of the control rod would not decrease during its useful lifetime. Europium is a rare metal because no large commercial market exists for it; actually it

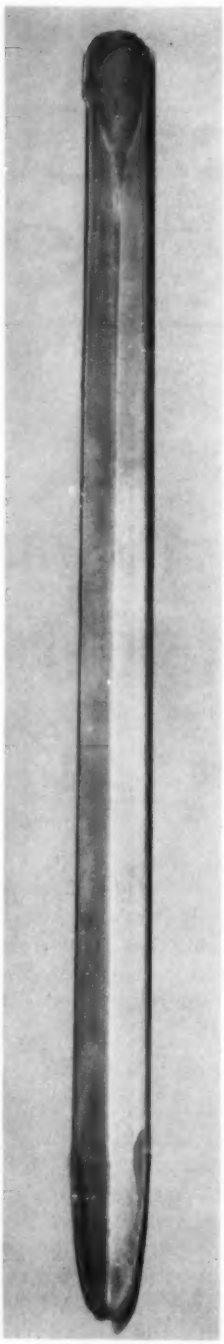


Fig. 1 – Control Rod, Stainless Clad, Extruded as One Piece. Core is 40% samarium oxide (the "poison"), 60% stainless steel

is more plentiful in nature than silver, bismuth, antimony or iodine. Since europium metal is quite reactive, the oxide was to be used instead of the metal. At the time of these experiments, a good deal of the oxide of samarium was available and it was used in the developmental program. Samarium oxide is quite similar chemically, mechanically and physically to europium oxide.

Briefly, therefore, the problem was to produce Y-shaped bars whose cross section would look like Fig. 2 – thin stainless cladding over a dispersion of Eu_2O_3 in 18-8 stainless steel.

The first step was the preparation of powder metallurgy briquettes (not sintered) such as the one sketched in Fig. 3. These briquettes are at 80% of their theoretical density and are prepared by room-temperature compaction of damp, blended powders at 60 tons per sq.in. The powders were of samarium oxide and stainless steel in proper proportion, blended together with 10 cc. of acetone per 100 g. of powder. The acetone promotes uniformity of the dispersion and acts as an "anti-gravity" agent (similar to water in wet concrete mix) in overcoming differences in densities and particle sizes of the oxide and the stainless steel. The stainless end shown in Fig. 3 is also an unsintered compact of about 80% density; the joint between the two is so shaped that the interface after extrusion will be perpendicular to the long edges.

To prepare a Y-shaped rod, three of these flat briquettes are machined, outgassed at room temperature, and forced into a three-bladed stainless steel can. This can, which forms the cladding on the final rod, is fabricated by welding together properly bent pieces of commercial stainless steel sheet,

0.020-in. thick. These are open at the ends. In order to provide material from which to machine a hub or connecting linkage between the poison-containing component and the maniupulating mechanism in the reactor, a cylindrical compact of stainless steel powder is used at the tail end of the blade assembly in the extrusion billet (see Fig. 4). This last-mentioned compact is at only 65% theoretical density so it will readily deform into and around the blade assembly during extrusion.

Figure 4 shows how all of these are assembled with soft steel accessories into a stubby round extrusion billet. At the very bottom is a disk of ⅜-in. mild steel plate (S.A.E. 1010) and on top of that is a cylindrical tail compact of stainless steel powder 3 in. diameter and 1 in. high, contained in a mild steel ring sufficiently thick to fill the billet can. On top of this is placed the Y-shaped assembly, three mild steel wedge-shaped blocks to fill the circle, and appropriate shims at the ends of the Y-legs. A truncated cone of mild steel then tops the assembly and it is sealed in a mild steel billet can.

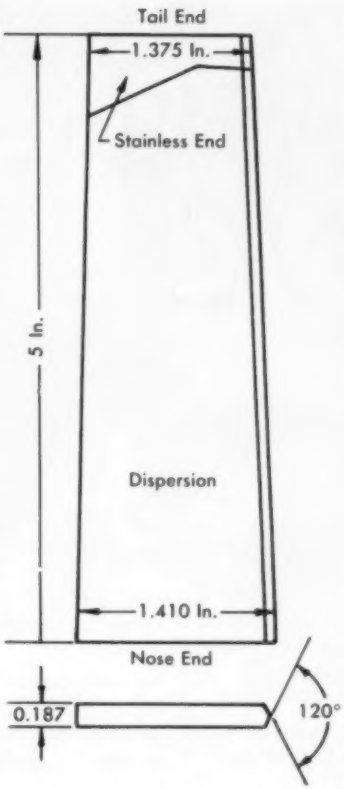
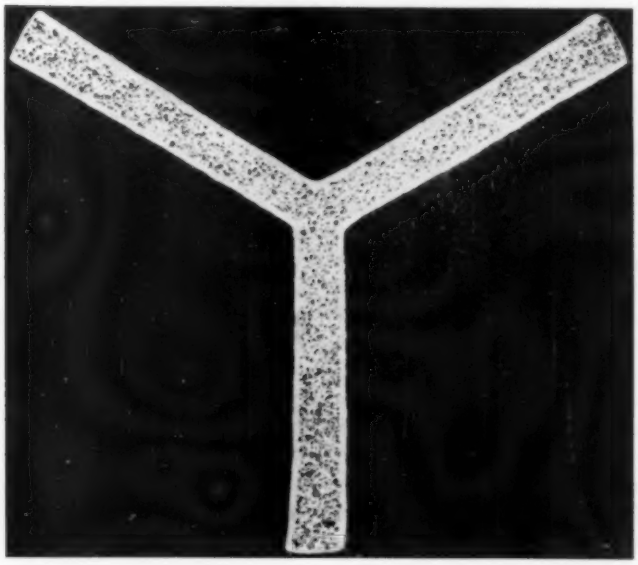


Fig. 3 – Compact which Will Form the Core of One of the Y-Legs

Fig. 2 – Cross Sections of Y-Shaped Control Rod; Dispersion of Poison in Stainless Steel, Stainless Clad



The function of these mild steel parts, which may be called the envelope, is two-fold – first to maintain the shape of the three-bladed assembly as it is compressed in the extrusion container, and second to permit extrusion of the Y-section through a round die, and thus to lower the total shear stress applied to the dispersion. It is important that the deformation characteristics of the envelope and the clad dispersion be similar; otherwise, the blades of the extruded rods will not have parallel sides. It should be noted that if the matrix material in the dispersion is changed, a corresponding modification of billet envelope composition becomes necessary.

The joints between component parts of the assembled extrusion billet of Fig. 4 must be very tight if dimensional reproducibility (± 0.005 in.) between extruded multi-bladed rods is desired. For this reason, the billets are assembled in a press, about three tons being required. The caps of assembled billets are arc welded in place; after the welds are checked for defects the billets are ready for extrusion. It is not necessary to degas the assembly before sealing. Clearances are so small and the assembly pressure so considerable that the operation resembles an ironing which progresses from the nose to the tail end of the billet. Most of the very small amount of trapped air remaining is expelled by expansion as the conical cap is welded on.

This billet is then heated to 1925° F. (1050° C.) and extruded through a die of bell-mouth shape

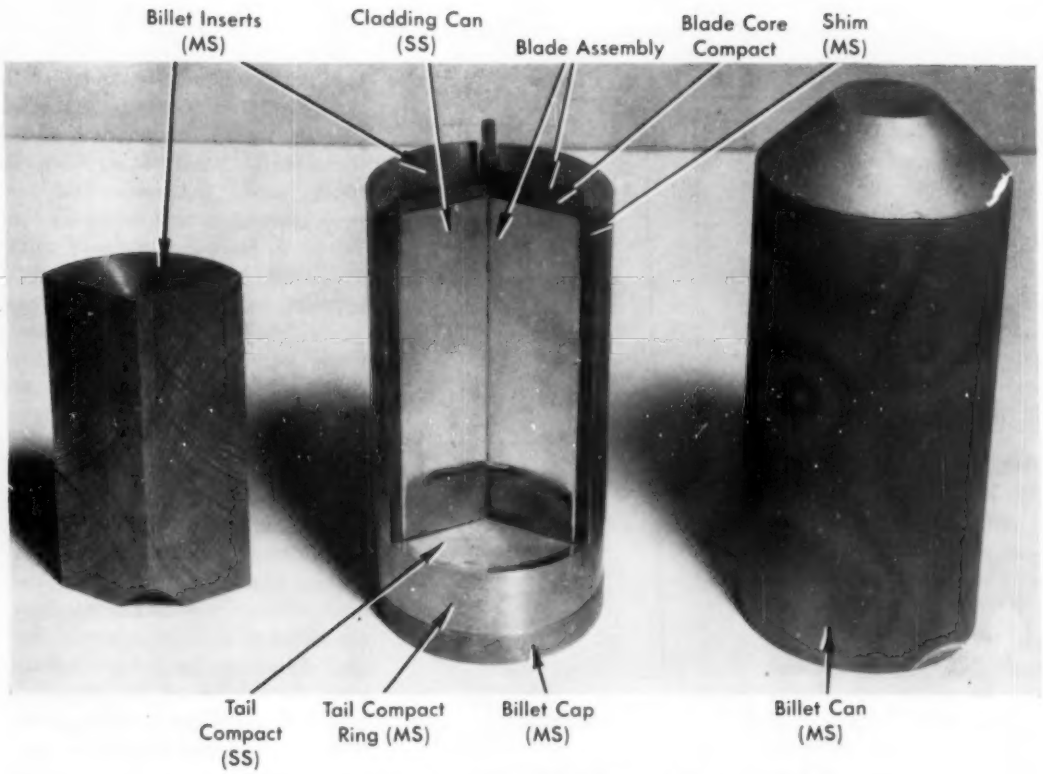


Fig. 4 – Partially Assembled and Finished Extrusion Billet. MS denotes S.A.E. 1010 steel; SS denotes 18-8-Cr-Ni steel

having a circular orifice of 1.625 in. diameter. Other extrusion conditions are:

Cylinder Diameter	3.550 in.
Lubricant	"Necrolene"
Extrusion speed	100 in. per min.
Die preheated to	900° F. (480° C.)
Cylinder preheated to	500° F. (260° C.)
Graphite cutoff block temp.	900° F. (480° C.)

The billet is preheated in a nitrogen atmosphere for 90 min., taken from the furnace, descaled with a wire brush, and returned to the furnace for a final 15 min. Behavior of hot billets of this sort in the extrusion operation is very much as though they were of solid mild steel. The extrusion is air cooled.

Pressure in the press cylinder or container and in the extrusion die is so great that the various portions of the original billet are completely bonded together. It is probable that effective anti-bonding agents could be discovered so the mild steel portions could readily be stripped from the others; so far, however, it has been necessary to dissolve the mild steel in hot 50% nitric acid – a time-consuming operation.

Using the above procedure, stainless-clad, stainless-Sm_2O_3 dispersions ranging in composition from 15 to 40% by volume of the oxide have been fabricated with entirely satisfactory results. Dispersions of Eu_2O_3 containing 5 to 30% by volume have also been fabricated satisfactorily. The dispersion appears to be quite uniform; variability is plus or minus 1% by volume from end to end of blade. Measurement of cross sections from a blade selected at random shows core thickness of 0.076 ± 0.004 in. and cladding thickness of 0.012 ± 0.001 in. end to end and leg to leg.

Structure and Uniformity

The cross-sectional structure of a typical, three bladed, as-extruded control rod has already been shown. Note that the blades are slightly thicker at their extremities than at their roots, due to the fact that the hot stiffness of the blades was greater than that of the S.A.E. 1010 billet inserts. As the billet entered the extrusion die, the blades were upset into the adjacent mild steel, giving the shape shown. The reverse, upsetting of the mild steel inserts into blades, was also observed in a titanium-boron rod with titanium cladding. A leg of uniform thickness can be had by adjusting the dimensions of the

compact of Fig. 3, or the hardness of the billet inserts (Fig. 4). It should be emphasized that the shape of the blades is extremely reproducible as long as the composition of the metallic parts of the billet assembly is held constant.

A typically good joint between blades is shown in Fig. 5. It also shows the random dispersion of oxide particles in the core; longitudinally they are in a somewhat elongated array. Evident also is the remarkably good bond between cladding (originally a rolled sheet) and the core which originally was an unsintered compact of about 80% theoretical density. This good bond seems to be due to a combination of causes. First, the inside of the steel can is throughly scoured by the stainless steel particles on the surface of the core compact when it is pressed into the can. Second, the compact is thoroughly outgassed to prevent any air pockets. Third, the hot extrusion billet is upset in the extrusion press cylinder or container before pressure is sufficient to cause much metal to flow through the die. Fourth, the pressure on entering and passing through the extrusion die is very high. Thus, bonding is produced in clean metal by an effective combination of hot pressing at 1925° F. followed immediately by a large amount of working at 1925° F. without any intervening opportunity to contaminate the bond.

A little difficulty was had at the start in getting a good joint at the roots of the Y, where the three 120° wedges abutted. Resulting cracks did not always follow the original joints between blade core briquettes and they passed through the matrix and the dispersed oxide particles more or less indiscriminately. This indicated that the joint was made, then broken during extrusion. Failures of this sort were traced either to the presence of oxide fines on the surfaces of machined briquettes, to quenching stress set up when extended samples were water quenched, or to both. Suitable preventive measures (such as wire brushing the machined edges of the compacts, and air cooling from the fabrication temperature) eliminated these failures completely.

Note that the core briquette of Fig. 3 has a plain stainless steel section at the tail end. The configuration between the two portions was used to explore the feasibility of preparing multi-bladed rods with poison only in the operating portions of blades. It was found that the plain stainless steel sections were 10 to 18% thinner than dispersion sections after extrusion when the two materials had the same theoretical density at start. When the plain stainless steel section



Fig. 5 – Magnified View of Cross Section of Joint at Center of Three-Bladed Control Rod After Extrusion. Core has 30% of oxide

is 10% more dense, the final thicknesses are substantially the same. The interface between the two blade sections is not a straight line, but a conformation which will approach a straight interface *after* extrusion. Theoretically such correcting curves should be rectangular hyperbolas, but this shape is difficult to machine, particularly in an unsintered briquette. The compromising pair of straight lines was therefore adopted, and the as-extruded interfaces deviated only about ±0.2 in. from linearity.

Summary

In conclusion it may be said that multi-bladed rods, consisting of a core wherein a rare-earth oxide is dispersed in stainless steel, encased in stainless steel cladding, can be fabricated by hot extruding through a round die with good dimensional control and reproducibility. The chemical homogeneity of the rods is in keeping with specifications for reactor components, and exploratory tests indicate that the rods will be satisfactory for reactor application, as far as their mechanical properties and thermal cycling resistance are concerned.

Bright Heat Treating the Nonferrous Alloys

*By CLARENCE E. PECK**

Atmospheres are specified for successful bright annealing of the principal nonferrous metals and their alloys, to avoid dezincification of brasses, and to protect properly powder metal compacts during sintering, or combinations during furnace brazing. (J2k, J23a, H15q, K8; EG-a38)

WHILE SEVERAL of the nine basic types of atmospheres listed in the first part of this article (*Metal Progress* for March 1957) plus steam have been and are being successfully used for bright heat treatment of nonferrous alloys, it is important to remember that all types of atmospheres used for heat treating nonferrous metals and alloys must be free of sulphur. Frequently this is lost sight of, since the raw fuel gas used to make the atmosphere is free of sulphur to begin with, and extra equipment to remove traces of sulphur would then be unnecessary. This remark applies to some natural gases and to tank propane and butane which has not had sulphur compounds added to give a warning odor to the raw gas. While this precaution is especially necessary for the copper alloys and silver alloys, it should be regarded as a fundamental principle for any new alloy unless it is clearly shown that traces of sulphur will not be harmful.

When even *small* amounts of sulphur (usually in the form of hydrogen sulphide and carbon disulphide) are present in the fuel gas, special precautions must be used to remove the remaining sulphur compounds present in the atmosphere after it has been mixed with air and burned in the generator.

This may be done by passing the atmosphere through a refractory-packed, water scrubbing tower followed by another filled with iron oxide. The first will absorb sulphur dioxide and the second hydrogen sulphide.

Copper – Annealing temperatures required to completely recrystallize and eliminate the cold worked structure in copper vary greatly with the amount of cold work. In general, the heavier the reduction in one operation, the lower the required softening temperature. Annealing temperatures may be as low as 350° F. (for thin-gage wire with a lot of previous cold work) to 1100°F. for heavy sections slightly reduced.

Controlled atmospheres for bright annealing of copper consist of completely burned fuel gases, sulphur and oxygen free, having at the same time only a slightly reducing effect. Water vapor and CO_2 content are not critical. Hydrogen content of the atmosphere should be 1% or less to avoid hydrogen embrittlement of electrolytic tough pitch copper, particularly for thin sections at temperatures above 750° F. This type of copper contains a slight amount of oxygen in the form of cuprous oxide (Cu_2O). When exposed to hydrogen this oxide reacts to form copper and water vapor; the hydrogen diffuses into the copper faster than the water vapor can escape by outward diffusion and an internal pressure to rupture the metal is built up.

Many nonferrous alloys and particularly copper can be bright annealed in an atmosphere of steam. Previous to the development of separately prepared atmospheres practically all

*Manager, Vacuum Equipment Projects Section, Industrial Heating Dept., Westinghouse Electric Corp., Meadville, Pa. This article should be considered as the product of the Industrial Heating Equipment Association. It is a portion of a paper presented before the I.H.E.A.-A.S.M. meeting, Oct. 9, 1956, the first part of which was printed in *Metal Progress* in March 1957. The present writer wishes particularly to acknowledge several sources of information in preparing this summary: the research and development reports of Westinghouse Electric Corp.; publications and photographs from General Electric Co., Surface Combustion Corp., Lindberg Engineering Co., Electric Furnace Co., Holcroft and Co., and Leeds and Northrup Co.

bright annealing of copper was done in this manner. Now many products made from copper and its alloys are "dry annealed" in a protective atmosphere to eliminate problems associated with "water staining". This is particularly true on the final or finish anneals of thin-gage copper strip and small-diameter wire. Considerable amounts of copper are still being annealed in steam, such as large-diameter bar, strap for electrical conductors and busbars. For the same basic reason many copper products, in intermediate and even final stages, are annealed without oxidation in direct-fired furnaces in which products of combustion are from burners set to produce zero oxygen.

Copper-Zinc Alloys (Brasses) – Annealing temperatures for brass vary with cold work and degree of temperature required. The range is from 700 to 1400° F. For brasses low in zinc and annealed at low temperature, ordinary combusted gas atmospheres, sulphur-free, such as noted above for copper, will anneal brass with only slight oxidation.

However, for practically all other conditions – higher zinc content and higher annealing temperatures – CO_2 and water vapor must be very low or eliminated entirely from the atmosphere in order to prevent attack on the zinc with resultant discoloration. The atmospheres which can meet these requirements are of three types:

1. Dry dissociated ammonia.
2. Lean combusted gas with CO_2 and water vapor removed.
3. Highly reducing reacted gases in which CO_2 and water vapor content are very low.

Vaporization of zinc, by itself, may dull a brightly finished part even with the proper atmosphere. Vaporization of metal is primarily a function of temperature. The higher the zinc content of the brass and the higher the annealing temperatures the more likely will be this trouble.

The results of numerous tests to determine the effects of these various atmospheres on the brasses at various temperatures are summarized in Tables I and II.

Copper-Silicon Alloys – It is important that atmospheres surrounding these alloys be pure and dry. Combusted exothermic gas atmospheres which are completely dried and free of CO_2 are suitable, as well as dry dissociated ammonia.

Copper-Tin Alloys – Lean or rich exothermic gases are preferred. Water vapor and CO_2 can be tolerated in atmospheres for these alloys.

Copper-nickel alloys are of two broad classes, cupronickels and nickel silvers.

Cupronickels are primarily of copper and nickel and contain no zinc. Lean or rich exothermic gases are suitable for bright annealing; CO_2 and water vapor are not critical constituents.

Nickel silvers usually contain zinc as well as nickel. The atmospheres required may be dry dissociated ammonia or purified exothermic gases. These are necessary to insure bright work on long cycles and on slow cooling of large masses of work.

If a nickel silver can be heated and cooled relatively fast, such as light-weight work going through a continuous furnace, the atmosphere can be simpler, consisting of a rich exothermic gas dried to low dew points without removing CO_2. An alternate would be a reacted endothermic atmosphere, which is usually practically free of CO_2 or water vapor.

Table I – Dezincification of Brass* in Various Atmospheres

Atmosphere	Dezincification		
	750° F.	1100° F.	1475° F.
Lean purified exothermic gas	None	Slight	Heavy
Rich exothermic gas	None	Slight	Heavy
Reacted endothermic gas	None	Slight	Heavy
Dissociated ammonia	None	Slight	Heavy

*There is no dezincification of low-zinc brasses (15% or less) up to 1475° F.

Table II – Surface Effects on Brasses at 1475° F.

Atmosphere	Dew Point	Content in Zinc				
		5%	15%	30%	35%	40%
Purified lean exothermic gas	+20° F.	4	4	4	4	4
	+10	1	2	4	4	5
	−40	1	1	1	1	1
Rich exothermic gas	+20° F.	3	3	3	4	5
	+10	1	2	3	4	5
	−40	1	2	3	3	3
Reacted endothermic gas (dried)	−20	1	1	1	1	1
Dissociated ammonia	+20	1	1	2	2	2
	−40	1	1	1	1	1

Code: 1. Bright. 2. Light oxidation. 3. Medium oxidation. 4. Medium heavy oxidation 5. Heavy oxidation.

Copper-aluminum and copper-beryllium alloys require pure dry atmospheres, such as purified exothermic gas or dissociated ammonia.

Aluminum alloys containing magnesium require lean exothermic atmospheres with moisture removed to approximately room-temperature conditions. This prevents a brownish color or blistering. Large volumes of such gas are used for purging out roll-oil vapors during the initial heating-up period.

Normal air atmosphere is generally suitable for most other aluminum alloys, as well as for commercially pure aluminum itself.

Magnesium – Lean exothermic atmospheres are suitable. Ordinary air with fractional percentages of sulphur dioxide may sometimes be sufficient. Heat treating temperatures are so low that the chemical and physical activities are much reduced in comparison with similar operations on copper and iron alloys.

Titanium and Zirconium – At temperature levels of 1100° F. or lower, oxidation of these metals is slight in an air atmosphere. At higher temperatures the only gases which are inert to titanium and zirconium are argon or helium. Since it has been proven that the strong titanium alloys must be very low in hydrogen, heat treating in a vacuum is the preferable method, not only to protect the metal but also to degas it of harmful impurities. A suitable furnace for such specialized work was briefly described by H. M. Webber in *Metal Progress*, July 1957, p. 71.

Nickel and its alloys (except those containing chromium) can be bright annealed in lean exothermic atmosphere, whose moisture content is not critical. Nickel-copper alloys (such as Monel) can be bright annealed also in lean exothermic atmosphere.

Nickel-iron alloys and various magnetic or electrical alloys require high reducing properties and entire absence of any carbonaceous constituents in the atmosphere. At low temperature ranges, atmospheres such as rich exothermic are suitable, but at higher temperatures dissociated ammonia or dry hydrogen is required.

Nickel-chromium alloys require pure dry hydrogen or dissociated ammonia inside a metal muffle. Practice would parallel that for the common austenitic stainless steels.

The precious metals, silver, gold and platinum can be annealed in lean or rich exothermic atmospheres without further purification. However, when alloyed with zinc (such as the lower-karat gold alloys), drying the atmospheres is necessary. Dissociated ammonia is also satisfactory.

Molybdenum – In the lower temperature ranges (1600° F. or less) the exothermic type atmospheres will prevent any serious oxidation of molybdenum. In the higher temperature range only pure dry hydrogen can be used to prevent oxidation – which, once started, easily reaches catastrophic speeds in sheltered regions where free circulation is prevented.

Sintering

The general requirement for sintering a powder metal compact is an atmosphere that has high reducing power. Interdiffusion of metallic particles in contact must not be prevented by oxidized surfaces. Rich exothermic gas atmosphere is used for brasses and bronzes. Endothermic gases or purified rich exothermic gases are desirable for sintering of iron powders. These same atmospheres are necessary to prevent decarburization in any application where such is a problem; on the other hand powder iron compacts may be converted into steel parts in a carburizing atmosphere.

In those cases where oxidation of chromium particles must be prevented, very pure dry hydrogen or dissociated ammonia must be used.

Generally speaking, problems involving surface activity between metal and hot gas are intensified in compacts where the ratio of surface to mass is very large. The whole subject is quite complex – sometimes it may be advantageous to *promote* oxidation as in the recent "SAP" articles, where a certain amount of aluminum oxide, formed in place, gives enhanced properties to aluminum compacts. Mixtures of metallic powder with nonmetallics (oxides, carbides, borides) require individual solutions.

Brazing in Controlled Atmosphere

A series of papers presented at another meeting of the Industrial Heating Equipment Assoc. and printed in summary in *Metal Progress* for July 1957, discusses generally the brazing operation in modern mass production and equipment therefor – furnace, salt bath and induction heaters. The following brief notes will extend that material into the field of brazing operations on nonferrous alloys.

The types of atmospheres required for joining metals by furnace brazing follow bright annealing in almost an exact parallel. The primary requirement in both is to surround the work during its entire heating and cooling cycle with an atmosphere with sufficient reducing properties to prevent oxidation of the metals being brazed

Table III – Atmospheres for Nonferrous Metals

Material and Process	Atmospheres* Giving Desired Results	Atmospheres* Commonly Used
Bright Annealing Nonferrous Metals (No sulphur in atmosphere)		
Copper	1, 1A, steam	1
Copper-zinc alloys (brasses)	1A, 2A, 4, 5, 6	2A, 4
Copper-silicon alloys	1A, 2A, 4, 5	1A
Copper-tin alloys	1, 1A, 5	1
Copper-nickel alloys (cupro-nickel)	1, 1A, 4	1
Copper-nickel alloys (nickel silver)	1A, 4, 5	1A, 4
Copper-aluminum or copper-beryllium alloys	1A, 4, 5	1A, 4
Aluminum and its alloys	1 or air	1 or air
Magnesium and its alloys	1 or air plus SO_2	Air plus SO_2
Nickel, nickel-copper and Monel	1, 1A,4, 5	1
Nickel-chromium alloys	5 or H_2	5
Silver; gold	1, 1A, 5	1
Gold alloys with zinc	1A, 4, 5	1A, 4
Titanium; zirconium	Argon; helium; vacuum	Vacuum
Molybdenum	Dry hydrogen	Dry hydrogen
Sintering; Powder Metallurgy		
Ferrous metals; low-carbon	2, 2A, 3, 4, 5, 6, 6A	2, 4
Ferrous metals; medium and high-carbon	2A, 4, 5, 6, 6A	2A, 4
Tungsten	5 or H_2	5
Molybdenum	Hydrogen	Hydrogen
Stainless steel	5 or H_2	5
Automatic Brazing or Soldering Operations		
Low carbon steels (copper brazing)	2, 2A, 4, 5, 6	2
Medium and high-carbon steels (copper-brazing)	2A, 4, 5, 6	4
Alloy steels, medium and high-carbon (copper brazing)	2A, 4, 5, 6	4
High-carbon, high-chromium steels (copper brazing)	5	5
Stainless steels (copper brazing)	5	5
Copper or brass (phosphor-copper braze or silver solder)	1, 1A	1
Cast iron (silver bronze)	2, 2A, 5	2
Aluminum (flux)	Air	Air

*Designation of Atmospheres:
No. 1 — Completely burned fuel gas (exothermic).
No. 1A — Completely burned fuel gas with CO_2 and H_2O removed (exothermic).
No. 2 — Partially burned fuel gas (exothermic).
No. 2A — Partially burned fuel gas with CO_2 and H_2O removed (exothermic).
No. 3 — Partially reacted or cracked fuel gas (endothermic).
No. 4 — Completely reacted fuel gas (endothermic).
No. 5 — Dissociated ammonia.
No. 6 — Partially burned dissociated ammonia.
No. 6A — Completely burned dissociated ammonia.

or the brazing alloy. The detailed comments on applications of atmospheres to annealing of ferrous metals as above (and the comments on stainless steels on page 108 of the article in March 1957 *Metal Progress)* also apply to atmosphere brazing and will therefore not be repeated. Table III above giving a summary of atmosphere applications outlines the types of atmospheres required for the principal brazing combinations. However, the following comments apply directly to brazing applications as such.

Furnace brazing of the brasses or other alloys containing appreciable percentages of zinc is done with silver brazing alloys and suitable fluxes to assure "wetting" of the brass by the silver. Subsequent cleaning operations are usually required to remove flux deposits.

Similarly in the brazing of aluminum and aluminum alloys special flux is required to insure good wetting and prevent local formation of aluminum oxide in the brazed joint. Air is the usual atmosphere.

Metallic muffle type furnaces with dry dissociated ammonia or pure dry hydrogen atmospheres are required for brazing stainless steels and the high-chromium bearing steels; copper or silver is the usual brazing material.

Nitriding steels, due to their aluminum con-

tent, require a flux even when using atmospheres with highest reducing power.

Heat resistant stainless steel brazing alloys trade-named "Nicrobraze" require an atmosphere of pure dry hydrogen and a muffle furnace. Atmospheres containing nitrogen, including the highly reducing type from dissociated ammonia, are unsuitable. Very strong joints with this alloy have been obtained by vacuum brazing rather than atmosphere brazing.

When decarburization of high-alloy toolsteels is to be avoided in copper brazing, and when it is also important to obtain bright work, then a muffle furnace and dissociated ammonia would be recommended.

Furnace Essentials

While numerous articles in *Metal Progress* during the last few years have described many of the furnaces widely used in America for modern heat treating operations, it might be well to summarize the basic requirements of furnaces using prepared atmospheres. These apply to equipment for handling all metals, ferrous and nonferrous.

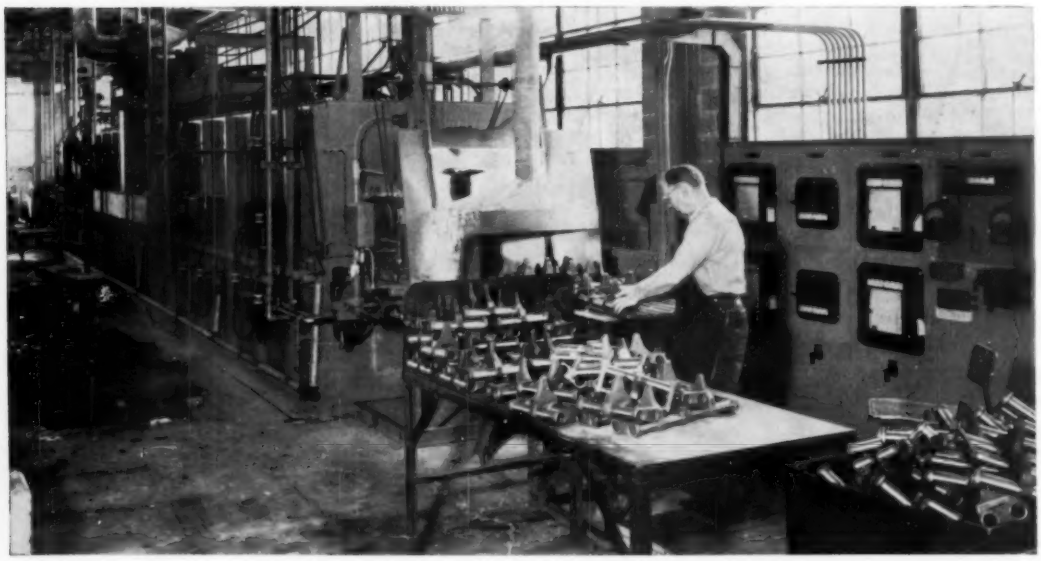
Controlled atmospheres are usually produced in separate equipment and then introduced into the furnace. The furnace must be capable of properly maintaining the necessary purity, or it will not produce the desired result. Certain common design features must be considered, and the following apply to all types of furnaces:

1. The principal furnace structure should be welded gas tight.
2. The refractories, heating elements, radiant tubes, muffles, material handling devices (trays, rollers, belts, chain) should be made of materials which will withstand the action of the atmosphere at the temperatures of operation.
3. All openings into the main furnace structure (power terminals, thermocouple tubes, pusher cylinder shafts, roll bearing shafts, circulating fan shafts) should be provided with easily serviced gas-tight seals.

In order to minimize the amount of expensive atmosphere required to keep the furnace properly filled without harmful contamination, the following additional factors must be considered. The extent of their use depends on the type of furnace:

1. Sealing devices at work openings, such as hanging curtains of flexible chain or asbestos cloth.
2. Flame curtains at the ends of continuous furnaces.
3. Doors of adjustable height, which can be operated either manually or automatically.
4. Purging chambers at the furnace ends.
5. Putting the furnace on a slope, or arranging in an A-frame shape or hump.

Fig. 1 — This Continuous Furnace Accepts Assemblies and Passes Them Through Preheat, Anneal, Brazing, Hardening, Quenching, Tempering, and Protected Cooling Without Intermediate Handling. (Courtesy General Electric Co.)



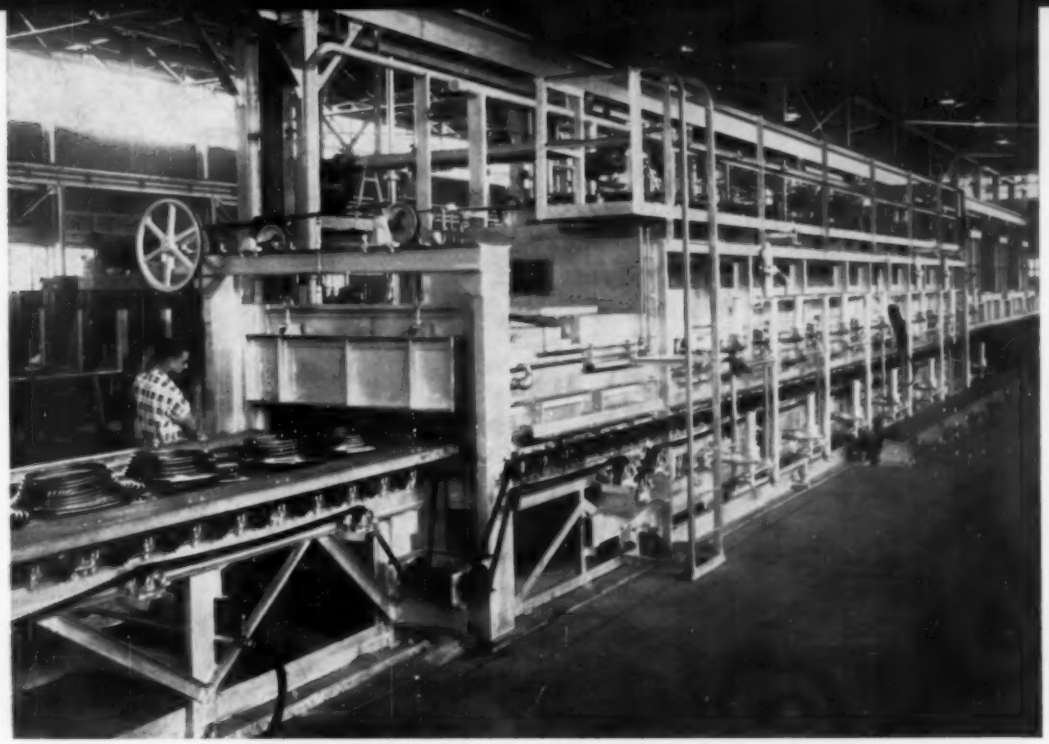


Fig. 2 — Continuous, Radiant Tube, Roller Hearth Furnace for Annealing Nonferrous Tubing, Straight or in Bundles. Material is handled on the driven rollers, including entrance and exit sections. (Courtesy Surface Combustion Corp.)

6. High-speed charge and discharge devices to minimize the time the doors must be open.

Such furnace designs are usually rather special, so they can meet the many requirements imposed by various applications of controlled atmospheres. The diversified experience of the furnace manufacturer can usually pinpoint the most desirable type of a particular process or requirement. The principal *basic* types resolve themselves into the following categories:

1. Continuous belt type or chain conveyer type furnaces.
2. Continuous roller hearth.
3. Continuous tray pusher type.
4. Bell type.
5. Elevator type.
6. Box type.

The following illustrates some typical controlled atmosphere furnaces which have incorporated into their design all the necessary basic factors for proper maintenance and purity of atmosphere for the particular process. Figure 1 shows an electrically heated, continuous, roller-hearth furnace which combines many heat treating operations with a brazing operation. Automatic operation reduces handling to merely loading and unloading and eliminates the intermediate work required when separate furnaces are used for each operation. The relatively short cycle allows the use of an inexpensive exothermic atmosphere, yet the result is bright work.

Figure 2 shows a large continuous furnace with roller hearth typical of those widely used for annealing nonferrous tubing, either coils or straight lengths. The type illustrated consists of an entrance chamber, radiant tube gas-fired heating chamber, and a long cooling chamber (forced convection type), and is suitable for any separately prepared controlled atmosphere. A variation of this type of furnace is direct fired; the products of combustion (properly controlled) are suitable for bright annealing of copper.

Many more examples could be given. In each it would be evident that the atmosphere and the furnace form a team; neither member is of any use in a process unless properly designed and applied to a specific problem. Numerous variables which enter into each application must be thoroughly appraised, since a wide variety of atmospheres and furnace equipment are available. This job can be done effectively by drawing upon the experience of equipment builders.

In summary it may be said that the present fields of applications are numerous and are growing. Refinements and further development will open up more fields in the future.

Casting Large Ingots of Uranium

*By G. W. P. RENGSTORFF and H. W. LOWNIE, JR.**

Sound ingots, 7 in. diameter, weighing 1200 lb. and with 91 to 95% recovery in metal, can be cast in iron molds after induction melting the uranium "derbies" in magnesia or graphite crucibles under open argon atmosphere. A small amount of barium chloride, added shortly before pouring, protects the stream of molten metal from oxidation. (C5j, 1-2; U)

MELTING OF URANIUM in quantities of 10 tons or more in open furnaces is attractive for lowering cost and producing a larger number of bars of similar composition than from a single heat in the small vacuum furnaces in current use. Furthermore, returned scrap can be more readily blended into the charge. Our experiments indicate that uranium can be melted in open furnaces successfully.

Ingots weighing up to 1200 lb. have been made by high-frequency induction melting in an atmosphere of argon and pouring under a protective cover of molten barium chloride or calcium chloride. The metal poured quietly and the amount oxidized was low. Average recovery in 600 to 1200-lb. heats was 91 to 95%. While these large ingots were not quite so pure as vacuum-melted ingots, their average carbon content was 0.04% and average nitrogen was about 0.010%.

In the experimental studies, melting conditions first were worked out on 100-lb. heats, modified with 600-lb. heats, and then adapted to the 1200-lb. heats. There should be no difficulty in expanding further to heats of 20,000 lb.

1200-lb. Ingots – Uranium's density, 18.7, makes it heavier than lead and about 2.5 times as heavy as steel or cast iron. This means that a 1200-lb. ingot can be melted in equipment sized for 500 lb. of steel; ten tons of uranium will fit into equipment capable of melting four tons of steel.

Its melting point is 2065° F. – close to the melting point of cast iron, so temperature is not a particular problem – but it is so reactive that molten uranium will burn in air. The loss from burning and other causes must be minimized because the metal costs about $18 per lb.

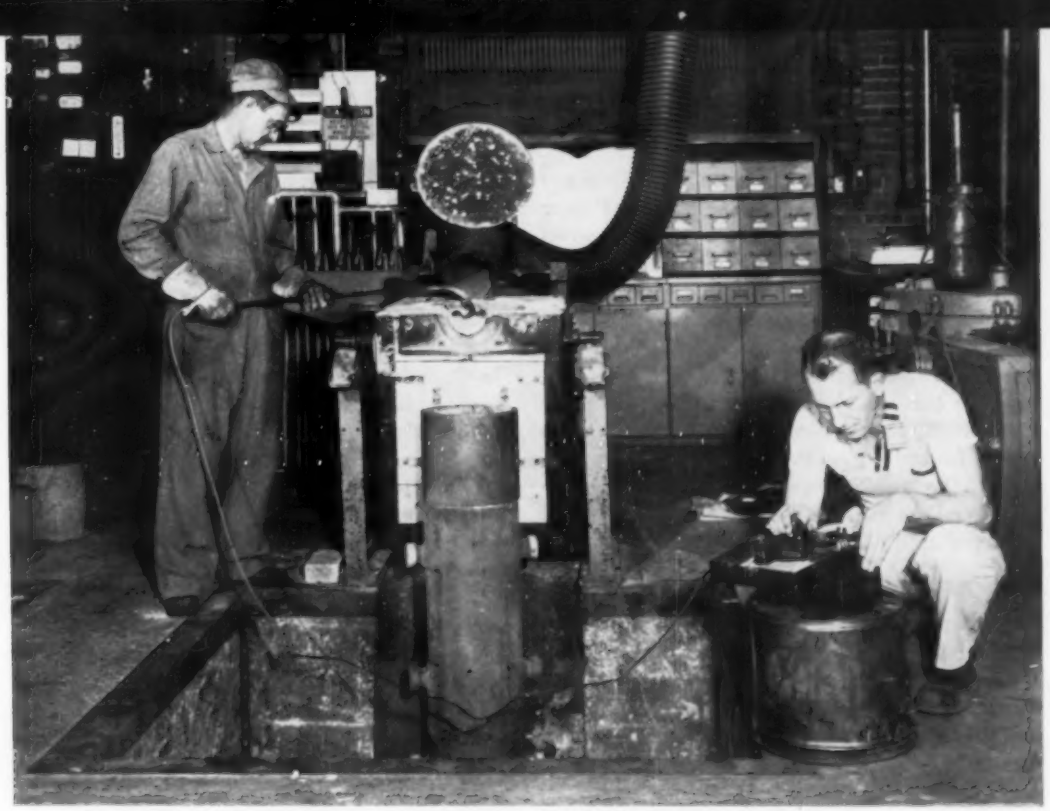
In our studies the uranium was melted in graphite or magnesia crucibles. Partial protection during melting was by a loose-fitting graphite cover on the crucible. Argon was introduced through a hole in this cover. A small amount of barium chloride or calcium chloride was added shortly before pouring; these salts formed a thin protecting surface over the stream of molten metal.

A graphite skimmer with a notch on one side was bolted to the top of the crucible just before pouring, and the molten metal was poured rapidly so the slag was held back in the furnace.

A graphite pouring cup on the ingot mold directed the molten metal down into the center of the mold. Without this, the stream eroded the side of the mold and caused difficulty in stripping. The most satisfactory pouring cup was a graphite cylinder with a funnel-shaped hole 12 in. in diameter at the top and 1.5 in. at the bottom.

The gray iron ingot molds measured 7 in. internal diameter, 2.25 in. thick and 56 in. high. A close-fitting copper stool cooled the base of

*Battelle Memorial Institute, Columbus, Ohio. This article is based on research at Battelle Memorial Institute for the Atomic Energy Commission under contract No. W-7405-eng-92, significant contributions to which were made by N. H. Keyser, R. M. Lang, G. J. Middaugh, H. Priest and H. A. Saller.



Measuring Metal Temperature Shortly Before Pouring. Note graphite furnace lid, swung up. Large tube is for ventilation. Immediately in front of induction furnace is ingot mold with graphite pouring cup on top

the ingot rapidly and promoted directional solidification. The inside was machined to a smooth finish, painted with aluminum paint and baked. The untapered ingots stripped easily 1 hr. after pouring.

To prepare the induction furnace for its first charge a 3-in. layer of electrically fused magnesia grain was rammed into the bottom, a graphite or magnesia crucible was set in place and centered in the coil, and magnesia grain rammed between coil and crucible. A layer of magnesia ramming mix tamped around the top held the crucible and magnesia grain in place. The lining was air dried overnight before firing with a gas torch for 4 hr. The furnace was then ready for use.

The charge of uranium was packed into the crucible as tightly as possible, so as to obtain effective electrical coupling and minimize the melting time. The charge usually consisted of a mixture of whole "derbies" of uranium and sawed derbies. "Derbies" are shaped as the name implies, and are the virgin metal reduced from uranium tetrafluoride by magnesium.

Melting and casting a 1200-lb. ingot required 80 min. with an energy input of 100 kw. at 2000 cycles per sec. The induction coil consisted of 22 turns of ⅝-in copper tubing that was wound to a spiral 17.5 in. internal diameter by 18.75 in. high.

The ingot mold, in place in the pit in front of the furnace, was preheated with a gas torch directed down its bore. To avoid oxidation in an open flame the graphite pouring cup was preheated to 400° F. in an oven and placed on the mold shortly before pouring.

During melting, argon was piped into the space between graphite cover and crucible at the rate of 0.25 to 0.35 cu.ft. per min. The charge was melted as rapidly as possible. About 5 lb. of barium chloride or calcium chloride was added to the furnace when melting was completed and shortly before the metal was poured. The temperature of the metal in the furnace was measured with a platinum thermocouple enclosed in a quartz tube covered by a graphite tube. (An optical pyrometer was unsatisfactory.)

When the metal's temperature reached 2450 to 2550° F., the graphite cover was lifted, the graphite skimmer bolted to the top of the furnace frame, and the preheated pouring cup was placed on the ingot mold. Molten uranium was poured into the ingot mold as rapidly as possible. After cooling for at least one hour, the ingot was stripped.

The recovery in large heats made in graphite crucibles (95% average) was better than in

magnesia crucibles (91% average). Recovery of small heats (70 to 100 lb.) made without cover – that is, in normal atmosphere – was 93% when melted in graphite crucible and 87.5% in a magnesia crucible; the respective figures when argon was piped into the crucible (small heats and no salt cover) were 96% and 93.5%. When the small heats were covered with barium chloride (no argon) recoveries were very good (98 to 100%) in crucibles of both sorts, but there was a frothy top on the solidified ingot which had to be cropped and which carried some uranium. As will be pointed out later, argon as a protective cover avoided this frothy top.

The Uranium Ingots

To determine the effect of melting practice, samples were taken from several portions of the ingots with special precautions to avoid oxidation during drilling. Analyses of duplicate samples showed that the sampling technique was satisfactory.

Most of the heats in magnesia crucibles contained 0.03 to 0.04% carbon; the heats melted in graphite crucibles were slightly higher, averaging 0.043%.

As the size of the ingots melted in graphite increased, nitrogen contents increased −0.003 to 0.005% in 100-lb. melts to 0.007 to 0.010 in 1200-lb. melts. Small heats made in magnesia crucibles had a much higher nitrogen content than heats made in graphite crucibles; the nitrogen content in 1200-lb. melts was about the same as those melted in graphite.

Barium and calcium in most of the ingots were less than 5 ppm. or 0.0005%, even when the salt was added at the beginning with the cold metal. The magnesium content varied from 6 to 39 ppm. (on the high side of the range in the small ingots and on the low side in the large ingots). Most of this came from residual magnesium and magnesium salts in the derbies, from metal used as a reducing agent to produce the metallic uranium.

Several 70-lb. heats were kept molten for extended periods at temperatures ranging from 2300 to 3000° F. to determine whether holding time had any effect on the composition of the metal. Samples were withdrawn periodically by immersing a Vycor tube in the melt and drawing up a sample with an aspirator bulb. After the melt solidified the tube was broken away.

The magnesium content of the melts decreased with increased holding time. Barium, carbon, and nitrogen contents showed no trend that could be related to holding time. The amounts of barium, carbon, and nitrogen in the melt varied somewhat, probably because of the small size of the samples. It was particularly encouraging to find that the carbon and nitrogen contents did not increase with time.

Protective Covers – Small melts were made in air under protective covers of argon or molten barium chloride and compared with similar melts which were unprotected. As noted above, even when the melts were unprotected, the recovery of metal was fairly good (87 to 93%). This was surprising because uranium oxidizes so easily. However, the protection finally adopted was argon because when molten barium chloride was in the crucible during the entire melting time, a frothy layer appeared on the ingot's top. Although the gross recovery was highest when barium chloride was used as a cover during melting, the net recovery of uranium after scalping the ingot was not so good as under argon.

Metal melted under air or argon appeared to burn slightly when it was poured through air into ingot molds. This was corrected by the addition of a small amount of barium chloride or calcium chloride a few minutes before the metal was poured. The metal then poured quietly and without burning, and there was no frothy top on the ingots.

Cast iron molds were used on the small 70-lb. heats and on the large 1200-lb. heats. Graphite molds were used for 600-lb. ingots. We noted no advantage in the graphite molds. The surfaces of ingots poured rapidly in cast iron molds were just as smooth, and they are cheaper and more rugged than graphite molds.

We also made some melts in a three-phase direct-arc furnace, both in the open and under a protective slag. Losses of uranium by oxidation were so high that it appeared to be uneconomical, and in view of the success obtained with induction melting, open-arc melting was not investigated further.

Conclusions

It is possible to melt heats of uranium weighing up to 1200 lb. in open induction furnaces. Good recoveries are obtained by protecting the metal with a blanket of argon during melting and with barium chloride during pouring. It is anticipated that little difficulty will be experienced in melting uranium in large heats (up to 10 tons or more) in open induction furnaces, or in casting uranium ingots weighing up to one ton or more.

Relief of Residual Grinding Stresses by Annealing

By H. R. LETNER
*and A. B. SAUVAGEOT**

Momentary heating of the surface (no more than 90 sec. in a salt bath) at 650° F. will relieve 80% of the internal stresses left by grinding. If softening of more than 1 point on the Rockwell scale is prohibited, 90 sec. at 500 to 600° F. will remove about half the surface stresses. (J1a, G18; TS)

IT HAS BEEN PROVEN that metal cutting operations inevitably induce some kind of residual stress at or near the finished surface. Such stresses are often inconsequential, or the service is such that they do no harm. On the other hand, there are situations in which surface stresses have an important bearing upon the performance of a part.

Grinding is by no means the only metal cutting operation which introduces residual stresses. However, it holds a unique position in that many metals and alloys are so hard they cannot be cut economically by any other means, and the residual stresses in these materials have an exaggerated effect upon performance. Consequently there has been more interest in grinding, so that much more is known about its stress effects than those of any other surfacing operation (with the possible exception of shot peening). The Grinding Wheel Institute has sponsored research in this field for ten years.†

The magnitude and distribution of grinding stresses can be reproduced over and over again, provided the conditions remain constant, yet only a small number of the commercial grinding operations have been studied experimentally. In those which have been investigated, the results show that certain parameters influence both the resulting stresses and the fatigue life of the ground surface.

Some combinations of grinding conditions produce compressive stresses at the surface which enhance fatigue life when stressed in preferred directions. This is a very desirable situation in every commercial grinding operation

*Formerly senior fellow and research associate, respectively, L. Leslie Byers Memorial Fellowship, Mellon Institute, Pittsburgh. Research sponsored by the Grinding Wheel Institute, Cleveland. Dr. Letner is now physicist, large lamp dept., General Electric Co., Cleveland, and Mr. Sauvageot is metallurgist, titanium section, Allegheny Ludlum Steel Co., Brackenridge, Pa.

†This work, now concluded, has produced many pertinent contributions to the literature. Reprints of papers that are still available for distribution may be had gratis upon request to Mellon Institute, Pittsburgh 13, Pa.

on critical parts, but unfortunately, the exact nature of the stresses resulting from a particular grinding operation, or their effect upon the service life of the parts, is usually unknown. Furthermore if correct conditions are not met, fatigue life of the finished part may be reduced. In this situation a stress-free surface is the safe alternative, and this points up the need for an effective and routine method of relieving residual stresses after the final grinding operation. Such a process should not affect the normal properties of the metal adversely and – if it is to be practical – must be simple and inexpensive. These considerations led to a series of experiments in which identically ground toolsteel specimens were annealed and the effects upon residual grinding stresses and hardness measured.

Fig. 1 – Principal Internal Stresses in Toolsteel Square, Quenched to C-64 Hardness, and Surface Ground 0.010 In. in Ten Downfeeds. Principal stresses shown: σ^1 parallel to direction of grinding, σ_2 at right angles

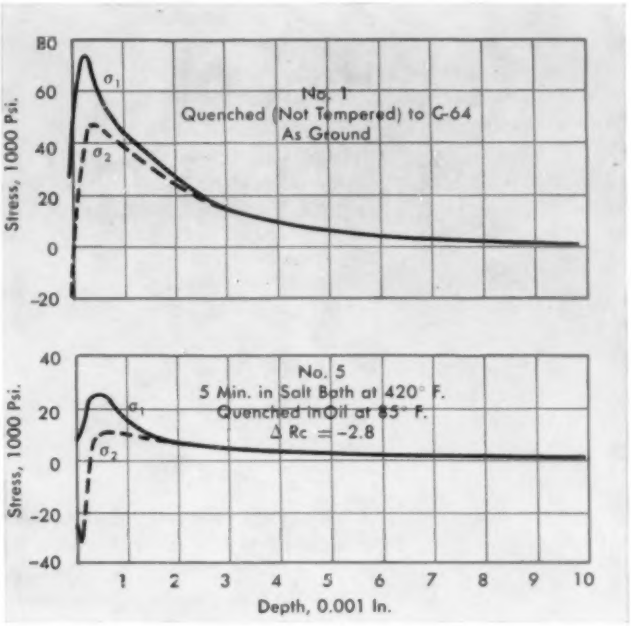


Fig. 2 – Sample No. 5 Originally C-64 Hard, Ground Like Sample No. 1, Annealed 5 Min. at 420° F. and Oil Quenched. Maximum grinding stresses are reduced at least 65%, hardness to C-61

Experimental Procedures

The steel for the study was an oil hardening toolsteel having nominal composition of 0.90% C, 1.25% Mn, 0.50% W and 0.50% Cr in the form of a 2 by 0.25-in. bar, in hot rolled and annealed condition. Two dozen 2-in. lengths were cut from the bar and about 0.040 in. was ground from one surface and 0.010 in. from the other, bringing the pieces to a thickness of 0.200 in. Specimens were then austenitized 15 min. in a NaCl-KCl salt bath at 1450° F. and quenched in agitated oil at 70° F., resulting in a hardness of Rockwell C-64. Half of the specimens were tempered 1 hr. in a $NaNO_2$-KNO_3 salt bath at 420° F. and allowed to cool in air, bringing their hardness to Rockwell C-59.

The 12 specimens in each hardness group were placed on the chuck of a horizontal spindle surface grinder and ground simultaneously in such a way as to produce predominantly tensile surface stresses. Ten downfeeds of 0.001 in. were removed.

Residual stresses were calculated by the deflection technique in which a thin layer is etched from the surface and the change in curvature resulting from the release of forces exerted by the removed layer is measured. The principal stresses, σ_1 and σ_2, are oriented in two directions parallel and perpendicular to the path of the abrasive along the surface. Layers were removed by etching in 10% nital or in 10% solutions of nitric acid in water, depending upon the rate of removal desired. Thickness of the layers was calculated from the loss in weight of the sample. Curvature changes in the directions of the principal stresses were measured with a Metron Model 20 comparator with a special fixture to accurately position the specimens. Figure 1 plots conditions as found in the hard (C-64) samples after grinding.

Stress relief was by heating in a salt bath (50% $NaNO_2$ and 50% KNO_3) in a small pot-type electric furnace with automatic temperature control. The specimens were immersed in the bath for predetermined times, and then were either cooled in air or quenched in agitated oil or water.

The first experiments were with the hard specimens (Rockwell C-64) and were of an

exploratory nature. Dipping momentarily in a salt bath at 1260° F. and quenching immediately in oil at 87° F. did not lower the hardness, nor did it lower the internal stresses. Boiling a sample 1 hr. in water and quenching in cold water also had an inconsequential effect upon hardness and stress.

Sample No. 5 (Fig. 2) gave the best results in this preliminary series; tensile stresses were reduced to less than one-third their initial values. Heat treatment was 5 min. at 420° F. and quenching in oil at 85° F.; hardness was reduced 2.8 points from C-64 to about C-61. Five minutes anneal at 420° F. seemed to be as effective as 1 hr. for relieving stresses; the longer anneal reduced the hardness from C-64 to C-59.5.

In commercial practice, steel is seldom ground in the as-quenched condition but is more frequently first tempered to C-60 hardness or below. For this reason, it seemed desirable to concentrate further experiments on the dozen specimens quenched and tempered to C-59. Internal stresses in these thin 2-in. squares after grinding are shown in Fig. 3. Starting from the conditions employed on as-quenched specimen No. 5, which showed the most promise, tests were conducted in which the annealing temperature, the immersion time, and the method of cooling were varied.

Fig. 3 — Principal Internal Stresses in Tool-steel Square, Quenched and Tempered to C-59 and Surface Ground. Sample No. 7

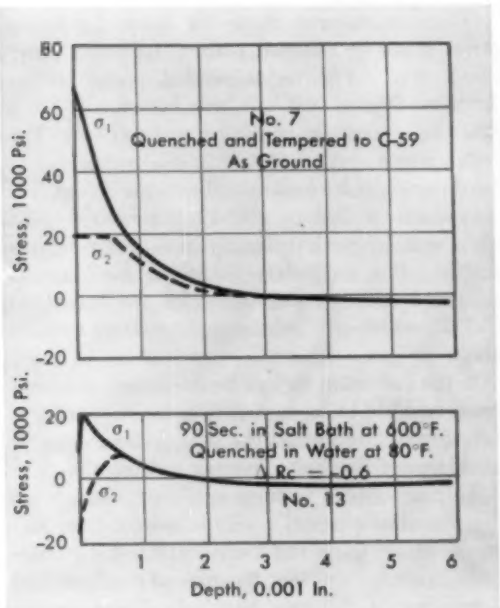


Fig. 4 — Ground C-59 Sample After 90-sec. Anneal at 600° F. Principal internal stresses from grinding reduced about 65%

Maximum principal stresses and hardness were not affected by a second anneal of 5 min. at 420° F. and air cooling. The same heat treatment followed by water quenching (85° F.) seemed to lower σ_1 and σ_2 close to the surface. Raising the temperature of the anneal, 600° F. for 5 min. and water quenching, was much more efficaceous, lowering σ_1 to 17,000 psi. and σ_2 to 6000, but hardness was reduced by at least 3 points on the C scale.

It appeared that a trend in the right direction would be toward the higher annealing temperature and shorter times. The decision to shorten the anneal to 90 sec. resulted from auxiliary experiments in which it was found that the surfaces of the specimens reached bath temperature within this interval.

Figure 4 shows stress conditions in sample No. 13, originally quenched and tempered to C-59, ground, then held 90 sec. in salt bath at 600° F. and quenched in water at 80° F. Note that maximum tensile stress in direction of grinding σ_1 has been reduced to 20,000 psi. and σ_2 to about half as much, while hardness has been reduced by only about half a point on the C-scale. A 90-sec. anneal at 600° F. followed by oil quenching or air cooling resulted in the same relief of stress, but reduced the hardness 1 to 1.5 points on the C-scale.

The 90-sec. immersion at 600° F. followed by water quenching showed so much promise that the effect of bath temperature was explored further, using the same immersion time. A summary of the results follows:

The pattern of internal stresses in samples No. 13 (Fig. 4), 14 and 15 is quite similar. That of No. 16 is shown in Fig. 5.

Sample	Anneal	σ_1 Max.	σ_2 Max.	Softening
14	500° F.	36,000	20,000	None
15	550	30,000	9,000	None
13	600	20,000	8,000	0.6 points
16	650	10,000	6,000	2.3

It is obvious that a 90-sec. immersion will substantially relieve grinding stresses without seriously altering the hardness of quenched and tempered steel. All the specimens treated as described in the table show appreciable reduction of grinding stress both in the direction of grinding and in the transverse direction; however, the higher temperature treatment permitted

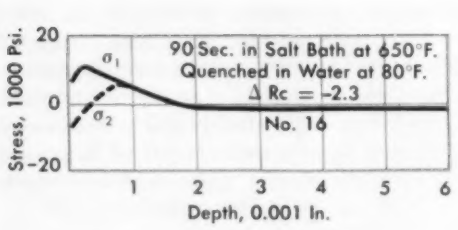


Fig. 5 — Internal Grinding Stresses After Relief for 90 Sec. at 650° F. and Water Quench at 80° F. Hardness loss is 2.3 points on Rockwell C-scale

some additional tempering to occur, resulting in a decrease in hardness. Perhaps the best results were obtained in specimen No. 13 (600° F.) which reduced the peak tensile stress 65% with no significant change in hardness. Specimens treated at 550° F. (No. 15) show somewhat less stress relief but are not greatly inferior to those annealed at 600° F. (No. 13). This illustrates the fact that exact temperature control is unnecessary.

Peak tensile stress may be used as a basis for comparison for at least two reasons: First, it is likely to be the most critical value related to fatigue failure of a part. Second, it occurs far enough below the surface so that measurements are reliable.

Comparison of Fig. 4 and 5 with Fig. 3 shows that the treatments not only reduced peak tensile stress but also relieved stress at all depths. The transverse stress was also favorably affected, converting the original tensile to a compressive stress near the surface as well as effecting general stress relief at all depths. (Compressive stresses are generally believed to increase fatigue life.)

Changes in hardness were determined by measuring the Rockwell hardness before stress relief treatment and again after stress analysis had been completed. The scatter of the data for each specimen indicated a precision of ± 1 point. The small hardness changes noted are therefore of doubtful significance. Nevertheless, it is believed that the temperature should not appreciably exceed 600° F. if softening by more than one point on the Rockwell C scale is to be avoided.

Larger Samples — Because shop operations generally involve larger sections than the specimens used in this program, the question of size should be considered. To relieve grinding stress it is only necessary to heat the surface, since the stress is confined to a layer only a few thousandths of an inch thick. To make certain that size is not a critical factor in this application, we studied the rate of heating in a salt bath at 600° F. of specimens ranging in size from the small rectangular blocks up to a 2-in. diameter cylinder weighing 11 times as much. Temperatures were measured by chromel-alumel thermocouples silver-soldered to the steel surfaces. All the surfaces either reached or were very near bath temperature within 90 sec. when the specimens were moved about in it. The cylinder was so large (about 10 cu.in.) in relation to the bath (about 100 cu. in.) that the 600° salt cooled to 550° F., but the temperatures of the salt and the block were equal 2 min. after immersion. This situation would probably remain had the bath been large enough to retain its initial temperature. Agitation was advantageous, particularly when treating the larger specimens.

Some of the experiments at lower temperatures indicate that water quenching after treatment may have a favorable influence upon stress relief. In specimens treated at 600° F., the method of cooling seems to have little bearing upon the amount of stress relief, but the softening is less if the specimen is more rapidly cooled.

Conclusions

These experiments show that residual grinding stresses can be relieved without softening hardened steel. The recommended procedure is: Immerse 90 sec. in a salt bath between 500 and 600° F.; quench in water or agitated oil. The temperature of the salt bath is not critical unless hardness must be maintained at a maximum. In the range of 500 to 600° F., from 40 to 65% reduction in peak grinding stress can be expected. If a small decrease in hardness can be tolerated, the temperature can be raised to 650° F., which will reduce peak grinding stresses about 80%.

If the softening cannot be tolerated, it would seem feasible to heat treat to a higher hardness before grinding so that the stress-relieving treatment brings the part down to specification.

This procedure is suggested even though all the potentially useful combinations of time and temperature have not been explored. Nevertheless, we believe that the procedure described is sufficiently effective, simple, and inexpensive to use commercially in the processing of parts in which residual surface stresses must be minimized.

Multi-Purpose Heat Treat

*By E. A. SCHOEFER**

Two in-and-out batch-type carbo-nitriding furnaces, a washing machine, unique arrangements of roller conveyers and extensive use of high-alloy castings (Type HT) form a combination suitable for hardening small parts made of various types of steel and cast iron. (W27g, 1-2, W27p, 17-7; ST, CI, SGA-h, 5)

How can you make a single heat treating furnace do three types of heat treating jobs, and enable the workmen to switch rapidly and efficiently from one type of heat treatment to another? This is usually a problem most often met in plants producing relatively small tonnages, but has been efficiently solved at the Farmall Works of the International Harvester Co. in Rock Island, Ill., where a wide variety of farm tractor parts are produced.

Among these are a number of small components which must be accurately heat treated in batches. For this purpose, a single gas-fired carbo-nitriding furnace was found most convenient. However, since heat treatments for different parts vary, and since small parts usually must be fixtured and loaded in different ways, two types of problems had to be solved: first, to design an efficient method of handling the varied parts up to the furnace door, and second, to obtain the specific properties needed by suitable heat treatment cycles within the limitations of a single furnace. In achieving both of these objectives, cast high-alloy trays, fixtures and furnace parts played useful roles.

To solve the serious handling problem, a unique conveyer layout was installed by Farmall Works' engineers. As shown in Fig. 1, it has several different types of sections. There are the fixed sections extending outward from the furnace door. A second type of fixed section might be called a storage section – the workman has his hand on it in Fig. 1. Immediately ahead of it is a loading section, which can be raised or lowered pneumatically. There are also two transfer sections (one at the extreme left in Fig. 1 and the other hidden behind the workman) which may be moved sidewise into alignment with the washing machine (middle left) used to wash oil from the parts after

*Executive Vice-President, Alloy Casting Institute, Mineola, N.Y.

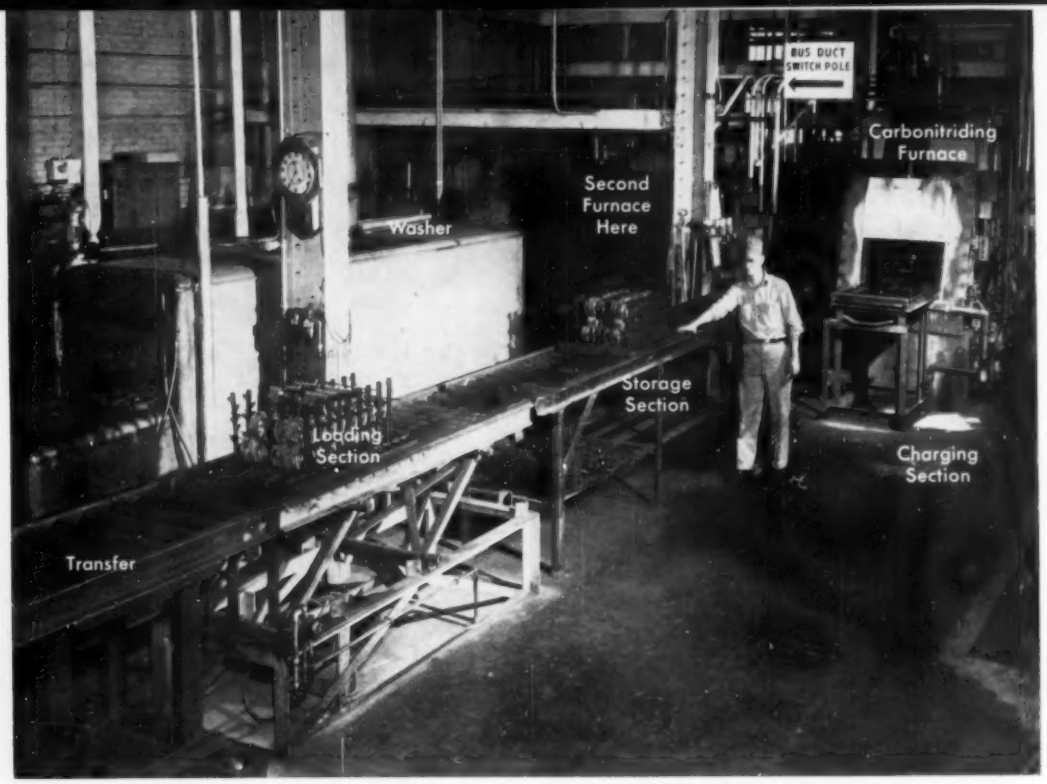


Fig. 1 – Simple Conveyer System Serving Two Furnaces and One Washer at Farmall Works, International Harvester Co.

quenching, or to the furnaces at the other end (one of which is hidden in shadow to left of the building column, Fig. 1.) This is an extremely handy arrangement, permitting the scheduling of varying work loads and – by virtue of the duplicate carbo-nitriding furnace – varying furnace cycles, all loaded from the same conveyer system.

Cast high-alloy trays or grids are placed on the loading section when it is in its lower position (Fig. 2). These trays can then be loaded conveniently with parts such as shaft couplings, ratchets, rail guides and the like, which are arranged on "Christmas tree" hangers. The operator then moves a lever, and air pressure raises the conveyer and its load to the level of the other conveyers (and furnace bottoms). It is then a simple matter to push the tray first to the permanent conveyer section and then to the transfer section. This is pushed sideways to line up with the furnace table, and at the proper time the furnace door is opened and the load pushed into the furnace vestibule, as shown in Fig. 3.

The furnace is an "in-and-out" type; after the required time at temperature the work load is pulled forward into the vestibule and lowered (conveyer, bottom, fixtures and all) into a quench tank immediately below. After cooling, an elevator returns the load to furnace-floor level, the outer door is opened, the load pulled out on the transfer conveyer, and moved across to the washer. Eventually the completed work reaches the original loading station where it is again conveniently handled by the furnace attendant.

The multiple heat treating requirements were met by a Lindberg batch-type furnace designed primarily for carbo-nitriding. For parts such as bearing races, shaft couplings and ratchets where surface hardness must be closely controlled without producing scale, a neutral gas atmosphere (endothermic generator gas with a dew point of 35 to 40° F.) is used at the rate of 380 cu.ft. per hr. Typical cycles are shown in Table I. This type of heat treatment is termed clean hardening since the parts emerge from the furnace free of oxide coating.

For many parts that have important wear surfaces, such as rail guides or thrust plates, the required extra hardness comes from carbo-nitriding. In this treatment a mixture of generator gas, natural gas and ammonia is used. Cycles vary from 1.5 to 5 hr. and temperatures vary from 1550 to 1650° F.

These two heat treating techniques – clean hardening and carbo-nitriding – are the usual ones in this furnace setup. However, for parts such as pump components, the required surface

Table I – Typical Heat Treating Cycles

Part	Material	Required Hardness	Cycle	Atmosphere†
Bearing race	Forged 52100	C-60 to 64*	2 hr. at 1550° F.	No. 1
Shaft couplings	1141 bar stock	C-25 to 32*	1.5 hr. at 1550° F.	No. 1
Stay rod cap	Nodular casting	C-45 to 52*	2 hr. at 1650° F.	No. 1
Ratchet	Nodular casting	Brinell 200 to 240*	2 hr. at 1650° F.	No. 1 (*a*)
Spacer	Gray iron casting	C-45 (min.)	1.5 hr. at 1600° F.	No. 1
Pump drivers	Forged C1015	File hard	3 hr. at 1650° F.	No. 2 (*b*)
Rail guides	C1010 sheet	File hard	1.5 hr. at 1550° F.	No. 3
Cam thrust plate	C1016 plate	File hard	5 hr. at 1600° F.	No. 3 (*c*)
Governor sector	C1010 strip	File hard	1.5 hr. at 1550° F.	No. 3

*Hardness specified obtained by tempering.

†Atmospheres — Endothermic generator gas with dew point of 35 to 40° F. is used for all treatments.

No. 1 — Clean hardening; 380 cu.ft. per hr. of generator gas—"neutral" gas atmosphere.

No. 2 — Carburizing; 380 cu.ft. per hr. of generator gas plus 15 cu.ft. per hr. of natural gas.

No. 3 — Carbo-nitriding; 380 cu.ft. per hr. of generator gas, plus 15 cu.ft. per hr. of natural gas, plus 25 cu.ft. per hr. of ammonia.

(a) This heat treatment puts nodular cast iron in a uniform condition with better machinability than as-cast. The wearing surface is induction hardened after machining. (Annealed nodular does not respond well to induction hardening.)

(b) All parts are oil quenched except this one, which is slow cooled in the furnace vestibule, machined, and then induction hardened on the driving surfaces.

(c) This part is ground after hardening, therefore is carburized for a longer time to give a greater case depth for grinding tolerance.

hardness is obtained by straight carburizing, enriching the atmosphere with the proper amount of natural gas, as shown in the table.

In all three methods, parts are usually oil quenched. Where an extremely hard surface and a minimum of distortion are required, the parts may be cooled in the furnace after the regular carbo-nitriding, by holding the load at 1300° F. in an atmosphere with no raw gas and doubled ammonia content, and then removing

Fig. 2 – Cast High-Alloy Tray Is Loaded While Conveyer Section Is in Lower Position. Note convenient work and handling height. A variety of tractor parts may be arranged on "Christmas tree" hangers





Fig. 3 – Charging (or Unloading) the Furnace. The floor of the entrance vestibule is carried on an elevator, so the furnace load can be lowered into an oil tank and quenched before it again comes in contact with air. Unloading is through the same door as shown in this view

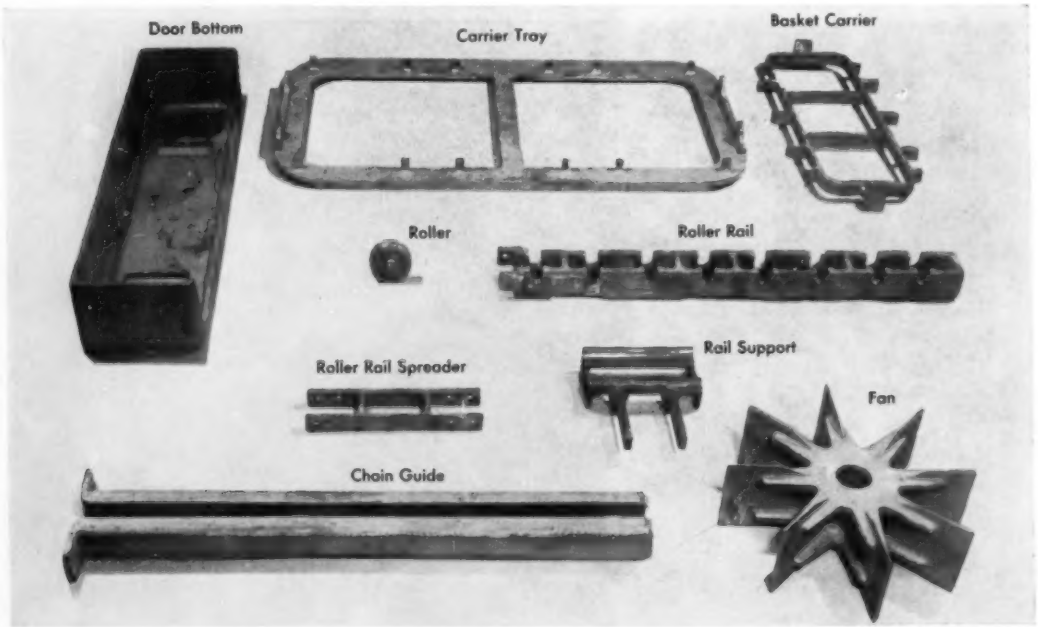
the load to the vestibule for cooling to approximately 300° F.

Cast High-Alloy Parts

To resist these severe conditions (especially the repeated heatings and quenchings), the vital furnace parts shown in Fig. 4 were made of Type HT cast alloy (nominally 35% Ni, 15% Cr, 50% Fe): door bottom, carrier trays, basket carriers, roller rails, rollers, rail supports, roller rail spreaders, chain guides, and the fan.

The fan is a particularly interesting component since the blades are cast integrally with the hub. Formerly wrought blades were fitted into a cast hub. It was found that any slight space between blade and mating hub section became the

Fig. 4 – Furnace Parts Made of Type HT Cast Alloy (35-15 Ni-Cr)



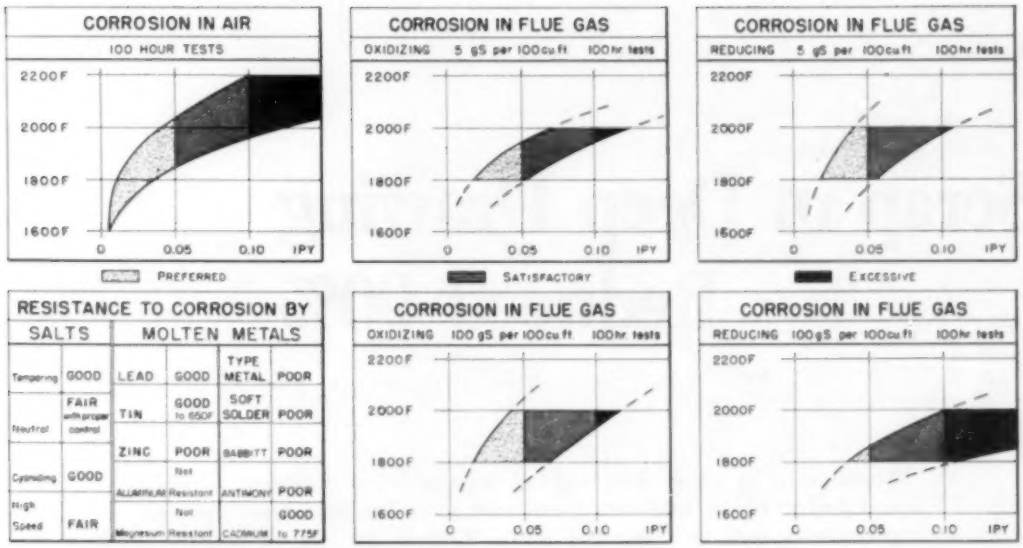


Fig. 5 – Diagrams Showing Resistance of Type HT Cast Alloy to Atmosphere, Sulphur Bearing Flue Gases, Salt Baths and Molten Metals. Horizontal ordinates represent inches penetration per year*

nucleus of a great deal of carbon deposition. The new, integrally cast fan blade and hub has eliminated this difficulty.

Because the cast high-alloy components are exposed to a wide variety of high temperatures and gas atmospheres, engineers for the Farmall Works and the furnace builder chose Type HT cast alloy for all of the grids and associated fixtures, as well as parts for the furnace hearth. Farmall's engineers report an average life of one year for the trays and fixtures; these go through the oil quench with the work. None of the cast high-alloy furnace parts has had to be replaced since installation in 1953.

Type HT cast alloy was selected because it has excellent hot strength at the operating temperatures, and good life under rapidly fluctuating temperatures. This austenitic alloy withstands reducing and oxidizing atmospheres, does not carburize excessively, and does not take up nitrogen in a nitriding atmosphere. Table II summarizes the mechanical properties at room and elevated temperatures. Figure 5 summarizes industrial experience on corrosion resistance of the alloy to various environments.

*From data sheet issued March 1957 by Alloy Casting Institute, Mineola, N.Y., one of 14 recently compiled by E. A. Schoefer and T. A. Shields from recent special researches and the technical literature.

Table II – Representative Properties of Type HT Castings*

Temperature	Tensile Properties			Stress to Rupture			Limiting Creep Stress‡
	Ultimate	0.2% Yield	Elong.	10 Hr.	100 Hr.	1000 Hr.	
70° F.							
As-cast	70,000	40,000	10	—	—	—	—
Treated†	75,000	45,000	5	—	—	—	—
1200° F.	42,400	28,000	5	—	—	—	—
1400	35,000	26,000	10	—	18,000	12,500	8,000
1600	18,800	15,000	26	11,000	8,500	7,000	4,500
1800	11,000	8,000	28	5,800	4,500	3,700	2,000
2000	6,000	—	—	—	2,500	1,800	500

*Composition: 0.35 to 0.75% C, 2% Mn, 2.5% Si, 0.04% P and S each, 0.5% Mo (not intentionally added), 13 to 17% Cr, 33 to 37% Ni, Balance Fe.

†Aged 24 hr. at 1400° F., air cooled.

‡Psi. for 0.0001% per hr. A frequently suggested design stress for direct axial loading is 50% of the limiting creep stress at *maximum* operating temperature.

Scrap in Deep Drawing Reduced 90%

*By C. KENNETH DIVERS**

Manufacture of wheel disks and hub caps of brass, stainless, and steel strip with minimum press room scrap has been correlated with preliminary tests on Olsen cup tester. Criteria are load to produce necking and corresponding height of cup. (Q23q, 1-4, G4b; Cu-n, SS, CN)

IN 1955, at the start of production on a hub cap made of 70-30 cartridge brass, we encountered excessive splitting (Fig. 1); approximately 2% of the parts split while drawing. All our usual testing methods failed to differentiate between good and bad material, and in this emergency, work was started on the Olsen cup tester. As is perhaps well known, this device clamps a sample of sheet securely except for a round area, and into the center of this area a spherical ball is pressed. The load at the point of necking is divided by the height of the cup; the quotient is the "drawability coefficient". A minimum cup height as well as a minimum drawability coefficient successfully predicted the drawing characteristics of the metal.

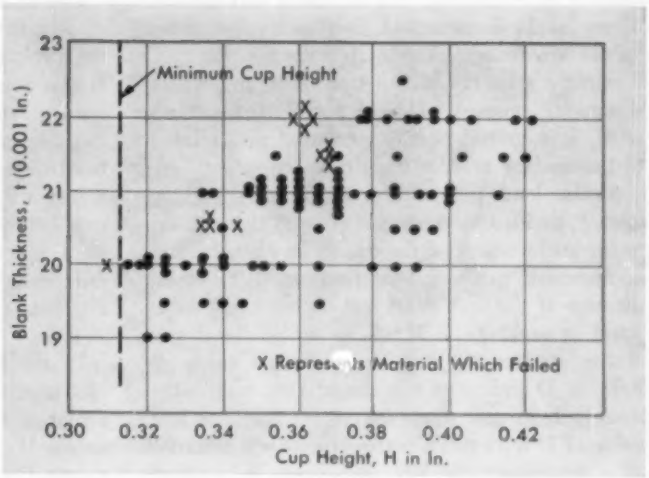
In the last two years the basic principles underlying this method have been proven on other jobs. This paper will describe our testing method and give other examples of its use.

*Supervisor of Quality Control, Brown-Lipe-Chapin Div., General Motors Corp., Syracuse, N.Y.



Fig. 1 – A Split Hub Cap After First Drawing Operation. Split has occurred in the area of highest stress

Fig. 2 – Relation Between Cup Height and Thickness of Blank



Examination of available literature and conversation with other metallurgists indicated that the cup tester, or ductility tester, is thought to indicate merely the drawing abilities of the metal under test. The consensus seemed to be that there are too many variables to accurately determine the drawability of metal. Among these variables are speed of testing, clamping pressure, lubrication of the test piece, width of the test piece, thickness of the test piece and precise determination of the end point.

Our experimentation showed that these variables (with the exception of the width of the test specimen, which was standardized at 3⅛ in.) have negligible influence. We found the maximum variation to be in the determination of the end point, in which plus or minus tolerances of 0.015 in. were encountered in reading the cup height. Consequently, three readings were taken by as many observers and averaged. Furthermore, this procedure was found to minimize the other incidental errors.

With a standardized clamping device, the width of the sample will have a considerable influence on side restraint. The effect of width on cup height of a single coil of 70-30 brass strip is as follows:

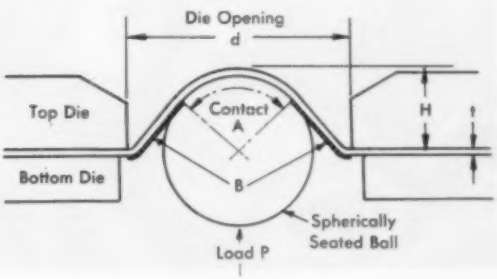
Width	Cup Height
2⅛ in.	0.450 in.
2⅜	0.413
2⅝	0.411
2⅞	0.395
3⅛	0.382

Quality control records were kept of the physical and metallurgical characteristics of material used for this part, as well as the performance of each skid of material in the press room. These records were then analyzed in an attempt to discover those characteristics which caused the splitting.

The first records analyzed were those from the Olsen cup tester. Cup height was plotted against performance and thickness in Fig. 2, and it will be noted that no correlation existed. In operating the tester the cup is drawn deeper and deeper until necking occurs (Fig. 4). The "cup height" is measured at the point of necking because, in production, necking of the metal results in a scrap piece.

This matter may be clarified by Fig. 3, which shows the cup in relation to the essential components of the testing machine. This shows that diameter d of the die opening remains constant, irrespective of the cup height H. It will also be noted that surface contact area A between stock and ball is dependent upon H, increasing as the cup becomes deeper. The cup height H is independent of the metal thickness, t, as H (at the end point) is measured from the same

Fig. 3 – Diagram of Olsen Cup Test



surface on which the dial indicator was zeroed. Thus, as H increases A increases, and these values are independent of t.

Surface area B is a function of H and A, for d remains constant. Thus, A and B are functions of H, a magnitude easily measured and related to the surface area of the drawn cup.

Stress, load per unit area, is equal to the load, P, divided by the area. Now as H is related to the surface area of the drawn cup by a rather complicated mathematical formula, P/H is indicative of the unit stress the material will withstand at necking. P/H will be called the drawability coefficient, D. Thus, a high value of P/H or D indicates a material that will withstand a high unit stress before fracture. A low value of D indicates a material that will fracture at a comparatively low unit stress. In other words, a high D indicates a more tenacious material than one with a low D. Likewise, the drawability coefficient D is easily derived by dividing the load P at the point of necking by the cup height H – both values being obtained from the cup tester.

Figure 5 plots the drawability coefficient against the blank thickness, the data being derived from the same tests as plotted in Fig. 2. It will be noted that 12 of the 14 tests on material which failed (marked X) are now at the left of the vertical D=6.7, the minimum for material that failed to perform satisfactorily, necking or splitting on the first draw or restrike. The material indicated by a dot denotes that which performed satisfactorily. It will be further noted that these values are independent of the metal thickness.

The drawability coefficient D, therefore, very closely ties in with the actual performance in the press room of 70-30 brass for the hub cap. It also appears that a minimum cup height exists for a given D; the smaller H becomes, P remaining constant, the larger is D. For example, a hard spring material would give a larger D than a soft, ductile material. Therefore a minimum cup height exists for a given material as well as a given D, and the two criteria serve to differentiate between "good" and "bad" material. For this part H min. = 0.314 in. and D min. = 6.7.

In the tension test a stress-strain curve can plot load vs. elongation (lb. vs. in.). However, a plot of D (related to stress, or lb. per sq. in.) versus H (in.) also shows lb. vs. in. A logical conclusion is that it should produce a curve similar to the load-elongation curve. Such a curve, the average from 12 tests on the Olsen cupping machine, is shown in Fig. 6.

Cup height has long been considered the criterion of drawability of the metal. Our results have shown the fallacy of this. A fine-grained metal has more capacity to absorb and distribute stresses than a coarse-grained one. A coarse-grained metal, however, will withstand more stretch and will produce a deeper cup than a fine-grained one. This relationship for 70-30 cartridge brass of constant thickness is as follows:

Grain Size	Cup Height
0.045 mm.	0.460 in.
0.035	0.446
0.020	0.422
0.015	0.409
0.010	0.373



Fig. 4 – Close Up of Drawn Cup, Showing Necking That Determines the End Point of the Test

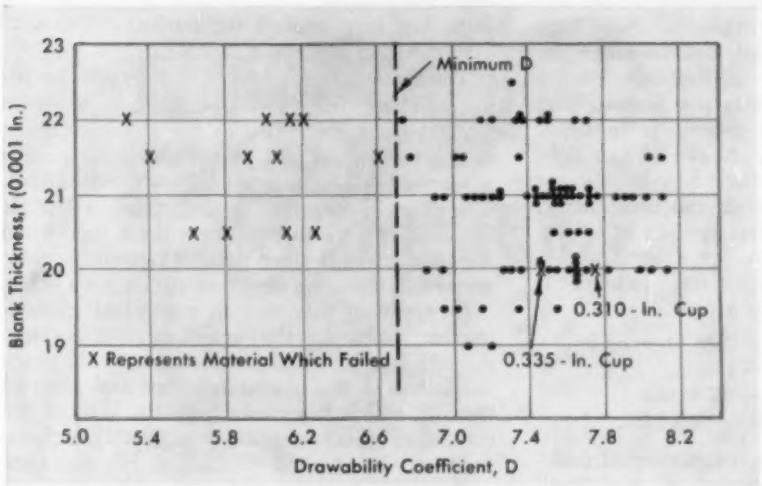


Fig. 5 – Drawability Coefficient for Tests of Fig. 2, Plotted Against Blank Thickness

The brass hub cap which was responsible for the work described above is a diametrically symmetrical part, and the results obtained are not necessarily applicable to nonsymmetrical parts. Research will be done in this area. It does not seem unreasonable to say that this technique would prove satisfactory for drawn parts of more complex nature.

As a result of these control studies, splitting of parts in the press room was decreased from 2% to 0.2%. The Olsen cup tester predicted 98% of the time the material that would split. All defective material was returned to the maker.

In another instance about 12 tons of Type 301 stainless steel was sent to us by one of our subcontractors for the manufacture of a wheel disk for a 1957 model of automobile. Material that we had been running on this job successfully had a cup height of 0.428 in. and a load of 5400 lb. This 12 tons of material had a cup height of 0.425 in. and a load of 4000 lb. and failed to make the part successfully.

Another example occurred at the start of 1957 production on a truck hub cap cover made of cold rolled steel. The material failed to make the part, splitting open on the first and second draw. It had a cup height of 0.343 in. and a load of 1614 lb. Since this time the raw material for this part has improved, and breakage has been reduced 75%; it has a cup height of 0.350 in. and a load of 2230 lb.

These examples point out the value of this testing method on various types of material – brass, stainless and cold rolled steel.

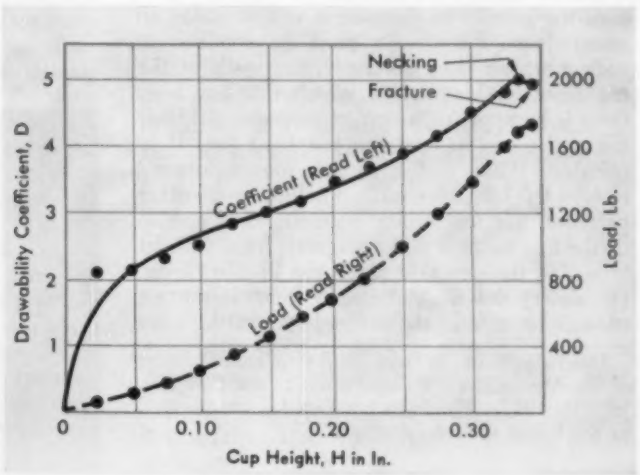


Fig. 6 – Drawability Coefficient and Load Versus Cup Height During Performance in an Olsen Cup Tester. Points represent average of 12 tests

Controlled Thermonuclear Reactions*

In the fission process heavy atoms like U^{235} or Pu^{239} break into fragments whose total mass is less than the original, and the difference is converted into energy – on the order of 200 Mev. (million electron volts) per fission. The mechanism of the fusion process is in many respects just the opposite. Nuclei of two light atoms join to produce a single heavier nucleus of somewhat lower mass than the constituents. Again, the difference in mass appears as kinetic energy of the new nucleus.

The promising reactions are four (wherein n represents a neutron and p a proton):

(a) $H^2 + H^2 \rightarrow He^3 + n + 3.25$ Mev. energy
(b) $H^2 + H^2 \rightarrow H^3 + p + 4$ Mev.
(c) $H^3 + H^2 \rightarrow He^4 + n + 17.6$ Mev.
(d) $He^3 + H^2 \rightarrow He^4 + p + 18.3$ Mev.

Reactions *(a)* and *(b)* of roughly equal probability involve only H^2 (deuterium) and there is enough deuterium in the ocean water – about 1 part to 6000 of hydrogen H^1 – to provide all of mankind's power requirements for millions of years. Reactions *(c)* and *(d)* have high energy yield and involve the products of reactions *(a)* and *(b)*. The energy per unit weight of reactants is slightly greater than in the fission process.

Formidable difficulties stand in the way of developing controlled thermonuclear reactors.

The first is producing the hundreds of millions of degrees required for the reactions to occur. At these extremely high temperatures, the only matter that can exist is wholly ionized gases – that is, positively charged nuclei (or ions) and negatively charged electrons. Such a gas is called a "plasma". These ions – all positively charged – repel each other strongly and they must be made to collide often enough at high velocities that they fuse rather than bounce away from each other. Such high velocities correspond to exceedingly high temperatures, higher than the interior of the sun; it will vaporize all materials so the plasma must be confined in such a way it does not touch the walls of the container. [One way in which this has been done is by applying a correct magnetic field so] the paths of the particles are bent into tight spirals. When such a particle moves outward toward the container walls it collides with other particles, but the strong magnetic field acts to tie the ions to the lines of magnetic force without impeding their motion *along* the lines of force. [In short] the magnetic field must be strong enough to confine the ionized gas at the very high temperature required and the confinement must last long enough for nuclear reaction to take place effectively.

The Pinch Effect – Several groups of scientists are working with the so-called pinch effect, which can be described as the self-constriction of a group of charged particles moving in such a way as to produce a unidirectional current. The effect is found in another case: A bolt of lightning can collapse a copper drain pipe when it passes through, since parallel circuits carrying current in the same direction attract each other.

In applying this fact to controlled thermonuclear research, the scientists are seeking, through heavy discharges of electricity, to pinch the atoms of the plasma together and suspend them in a thin line away from the wall of the container. Very high temperatures have been produced in pinched discharges, but the time during which these can be maintained, at present, is in the range of microseconds. As yet, the pinch is not fully stable.

The Los Alamos Scientific Laboratory began pinch experiments in 1952 using a doughnut-shaped tube and electrical equipment able to maintain currents of 10,000 to 50,000 amp. for some thousandths of a second longer than had been possible before. For short-time studies (duration less than five microseconds) straight tubes are used.

The pinch effect is but one of a number of alternate approaches being pursued in the Commission's controlled thermonuclear program. Each approach involves different configurations and different mechanisms of plasma heating and confinement.

Of course no isolated plasma can remain at a high temperature if it gives off energy faster than it generates it [by one or more of the four reactions noted at the beginning]. When the temperature is increased, the rate of nuclear reaction rises more rapidly than the rate of radiation; accordingly there is a minimum temperature below which the reaction cannot sustain itself. This so-called ignition temperature turns out to be independent of the density of the plasma, and for reactions *(a)* and *(b)* it is approximately 400 million degrees. For reaction *(c)* it is somewhat lower.

All the work is still very much in the research stage. It is anticipated that many years of intensive work will be required to develop a prototype thermonuclear device which would yield more energy than it would consume. After that, many more years would be required to develop a full-scale device which might have a chance of competing economically with other sources of power.

*Verbatim excerpts from 22nd semi-annual report of the Atomic Energy Commission to the Congress, July 31, 1957. Words in brackets [ ] are inserted by the Editor of *Metal Progress*.



Short Runs...

Resistance Wire Improved by Vacuum Melting

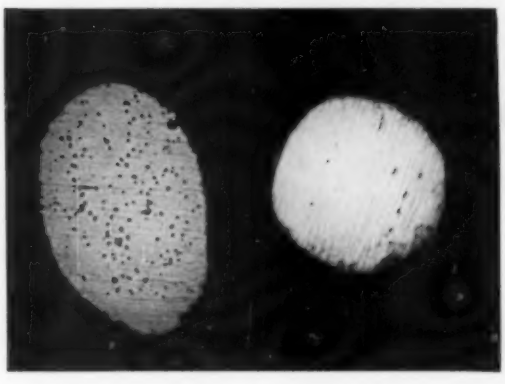
*By CHARLES G. GILBART**

POTENTIOMETERS are widely used for pyrometers. Electronics specialists are now requesting that the coefficient of resistance be cut in half.

Many kinds of high-grade resistance wire have long been available commercially, regularly produced at 0.001 to 0.002 in. diameter with a temperature coefficient of resistance of $\pm 50 \times 10^{-6}$ per °C. from −50 to + 100° C. Wire having a coefficient of $\pm 20 \times 10^{-6}$ is hand selected from commercial wire.

The primary interest is in wire which has a high specific resistance – more than 800 ohms per circular mil foot, a requirement which can be met by an alloy containing 50 to 80% nickel and 15 to 20% chromium (with minor additions of aluminum, copper, iron, manganese or molybdenum). It is drawn from induction melted ingots weighing several hundred pounds, but customary foundry practices introduce oxide inclusions into the cast ingot. See the left section in the micrograph. To investigate wire without inclusions we turned to vacuum melting in a National Research Corp. laboratory furnace. A self-supporting cylindrical tungsten heating element was used for melting the alloy. A vacuum of less than 5 microns was maintained except during pouring when pressure rose momentarily to about 60 microns. Magnesia (periclase) was the most suitable crucible material.

Fine Ni-Cr Resistance Wire; Unetched; 500 ×. At left is wire from induction melted ingot; at right is superior wire from vacuum melted ingot



In the initial work, a melt of Wilbur B. Driver's "Evanohm" (nominal analysis 75% Ni, 20% Cr) was cast into an unheated split carbon mold, and the ingot scalped to remove any adhering carbon. Since then a chill copper mold has been found more desirable. A tapering hole 6½ in. long with an average diameter of ½ in. was drilled through a copper slug 2 in. in diameter, and placed small diameter down in the furnace and plugged with refractory cement.

Usually it is difficult to melt chromium at reduced pressures because of its high vapor pressure. If intimately mixed metal powders are melted and held at the melting point for a minimum time, the chromium loss can be held to a fraction of 1%.

Two selected ingots cast by the above procedures were sent to Wilbur B. Driver Co. to be made into 0.002-in. wire in regular production equipment. Resistance turned out to be 184.5

*Physical Metallurgist, Materials Div., Research & Test Dept., U.S. Naval Avionics Facility, Indianapolis, Ind.

to 188.5 ohms per ft., and coefficient of resistance in the range −50 to +100° C. was between −17 and -2.4×10^{-6}.

These figures for temperature coefficient of resistance are very considerably less than for standard commercial wire. The samples were very clean metallurgically – see the right hand portion of the photograph. This manufacturing method seems to offer the possibility of consistently producing wire with a temperature coefficient of resistance of $\pm 10 \times 10^{-6}$ per ° C. The demand for such wire is increasing in proportion to the complexity of modern electronics.

Portable Spectrometer for Identifying Metals

*By LOUIS E. OWEN and ROBERT F. O'CONNELL**

METALS ARE regularly analyzed by spectrograph. It is a rapid, inexpensive quality control for routine samples. The same principle, operating with a simple visual spectrometer, can rapidly sort metal and avoid incorrect use. For this purpose we have assembled a portable rig which can operate in shop or field.

The portable rig shown in the photograph consists of a visual spectrometer mounted to receive light from spark discharges both of the metal being typed and a reference metal. Retractable cables hook up the built-in spark source to any 115-volt supply line. The sample stand is grounded to eliminate electrical hazards. The rectangular frame mounted on the table just ahead of the operator is a safety guard. The reference metal is mounted on a pillar just behind the sample stand. The metal box on the shelf contains the spark source; the wooden boxes hold reference samples and camera attachments.

Set-Up for Identifying Metal in a Pipe Flange



The angle-iron frame, casters, and spark stand are strong enough to carry parts weighing up to one ton resting directly on the rig. As illustrated, a crane can suspend more massive assemblies for determining the alloys in larger components.

As is well known, the spectrometer separates the characteristic light which metals emit when sparked into its component colors. Comparing these colors with those from a known metal, simultaneously sparked, enables us to type the metal or alloy. If the differences are too subtle for visual comparison, the eyepiece is replaced with a camera attachment; a circuit controls time exposures, and the resulting photograph is then compared with standards.

Experience has shown our unit to be useful for most commercial unalloyed metals. Monel, Inconel, stainless and low-alloy steel, as well as several copper-base alloys and at least ten aluminum types are easily differentiated.

To summarize, this portable spectrometer can rapidly identify small metal samples in the laboratory, can identify in the field critical components on large fabricated assemblies, and saves time and money by identifying metal stock prior to fabrication of special equipment.

*Technical Div., Goodyear Atomic Corp., Portsmouth, Ohio. Mr. O'Connell is now with Combustion Engineering, Inc., Windsor, Conn. Work performed under Contract AT-(33-2)-1 with the U.S. Atomic Energy Commission.

Explosion of a Titanium Crucible

*By CLO E. ARMANTROUT and JUNE R. HAUGER**

EXPLOSIONS of titanium (commercial grades or alloys) with various mixtures of fuming nitric acid have been recorded and the danger-

ous concentration limits of NO_2 and water have been established. However, as far as we know there has been no mention of explosive reactions involving titanium and highly oxidizing basic fluxes, such as observed recently in one of the Bureau of Mines' laboratories.

We have long used crucibles made of commercial grade of zirconium as a substitute for platinum to carry our fusions with sodium peroxide. Such zirconium crucibles have been in use for at least five years. Hundreds of fusions have been carried out in zirconium crucibles without accident.

Similarity in corrosion resistance under highly oxidizing conditions between titanium and zirconium at high temperatures led us to consider the cheaper titanium as a crucible material. Therefore, some crucibles were drawn from titanium sheet of commercial grade. A few trials showed that titanium was badly attacked by molten flux, and use was discontinued.

In one test a titanium crucible was charged with a high-chromium slag and flux consisting of sodium peroxide and sodium carbonate. The crucible was supported by a tripod and heated by a slightly reducing gas flame. Within a few seconds the appearance of the charge indicated that the temperature was unexpectedly high. The crucible was cooled, emptied and cleaned for re-use.

The following day a similar charge was placed in the same crucible and it was again heated, being extremely careful to limit the temperature to 750° C., as indicated by a dull-red appearance of the charge. (The usual temperature range for conducting these fusions is 700 to 800° C.) However, after a lapse of 30 to 60 sec. the charge became white hot. As the crucible was being set on the stone bench it exploded with a bright flash and a loud, sharp report. The photograph shows conditions before and after.

Titanium Crucible Involved in the Explosion Alongside a New Crucible



Small round particles attached at the hole's edges appeared to have been formed from molten metal. Microscopic examination revealed the normal acicular structure of beta titanium, thus indicating that the temperature far exceeded 870° C., the transformation temperature.

After the explosion a similar charge was placed in a zirconium crucible and melted by the same procedure without any unusual reaction. While we cannot explain the mechanism involved in this explosive reaction, we strongly recommend extreme caution when using titanium in contact with highly oxidizing substances, even at moderate temperatures.

*Respectively Supervising Physical Metallurgist, and Chemist, Bureau of Mines (U.S. Department of the Interior), Albany, Ore.

Etchant for Stainless Type 403 Forgings

*By RICHARD D. BUCHHEIT**

IT IS SOMETIMES difficult to develop flow lines and macroscopic structure in heat treated steels with the common recommended etchants. For example, hot 50% HCl was unsatisfactory for a martensitic Type 403 stainless steel forging. Etching 1 to 10 min. merely developed an overall pepper-and-salt appearance, as shown in Fig. 1. Another solution, consisting of 38% HCl, 12% H_2SO_4 and 50% H_2O, has been recommended by forging manufacturers, but was little improvement.

We then turned to an electrolytic etch. The bath consists of 20 cc. ethylene glycol, 20 cc. HNO_3 and 100 cc. ethyl alcohol (absolute). The specimen should have a semifinal or final polished surface; occasionally etch polishing may be necessary. The procedure is as follows:

1. The specimen is made the anode in a cell having a stainless steel cathode and source of direct current.

2. The cell voltage is adjusted to supply a current denisty of about 3 amp. per sq.in.

3. Instantaneous contact is made with the

*Assistant Division Chief, Metallography Laboratory, Battelle Memorial Institute, Columbus, Ohio.

specimen, causing noticeable electropolishing at the specimen edges.

4. The current density is cut approximately in half. Light repolishing is sometimes necessary before proceeding to the next step.

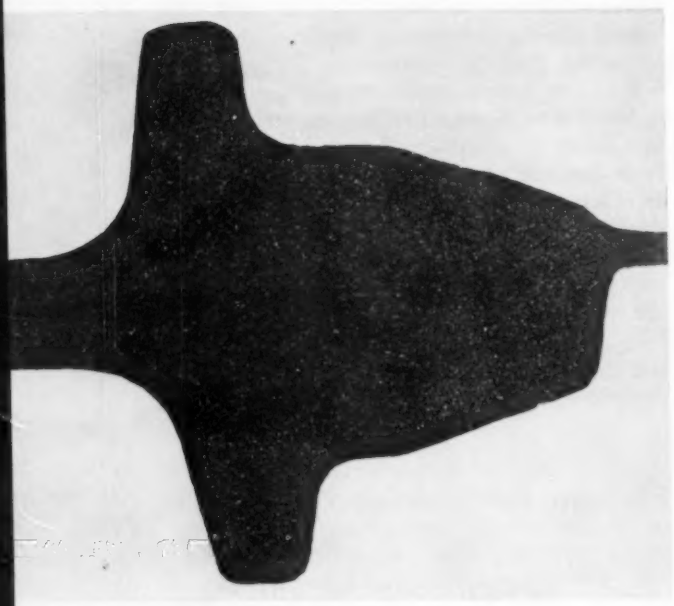
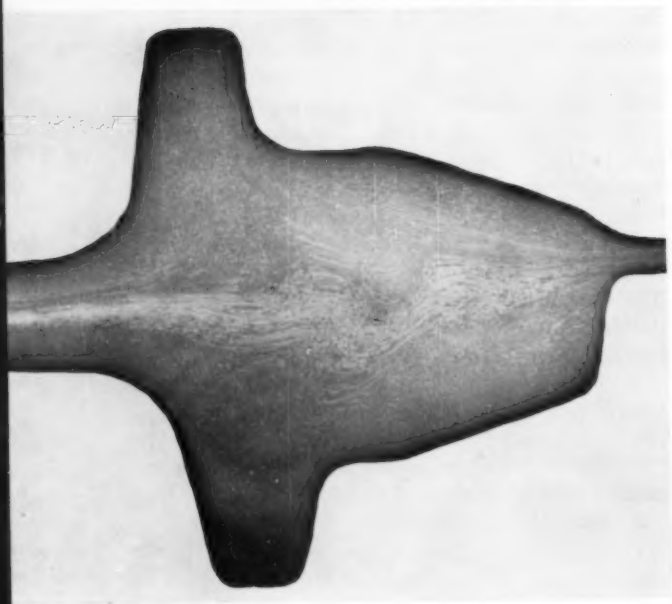


Fig. 1 – Type 403 Stainless Forging, Etched 10 Min. in Hot 50% HCl. 3 ×

Fig. 2 – Same Forging, Etched Electrolytically to Develop Flow Lines



5. Contact is made with the specimen for 15 to 30 sec. to produce a satisfactory etch (Fig. 2).

This etchant was first used by us some years ago on cobalt-base alloys. Since then we have used it on several metals and alloys successfully after other solutions have failed or were unsatisfactory. Some of these materials are chromium and chromium-base alloys, Illium G, Illium R, Jelliff 1000 alloy, Type 310 stainless steel and a 70-20 Ni-Cr base alloy.

Most nickel-base and chromium-base alloys and high-alloy steels can be successfully etched with this electrolytic method. It has not proved successful for marco-etching low-alloy engineering steels; however, these usually respond to such solutions as hot 50% HCl.

Rate of Strain Nomograph

*By WM. H. MATHER**

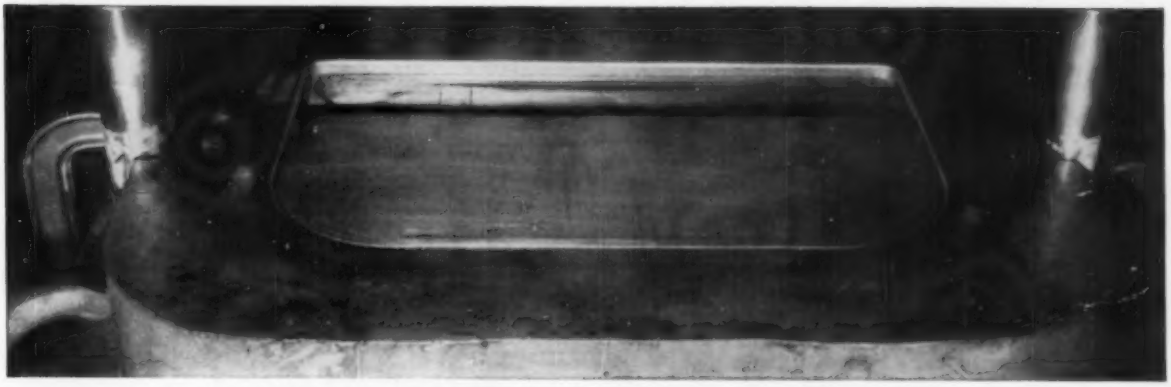
THE STRAIN RATE NOMOGRAPH on p. 96-B was designed for getting a close approximation of strain rate in mechanical testing. Knowing the Young's modulus of the material being tested, and knowing (approximately) the load to which the strain is to be paced, the operator can determine the time to give a predetermined strain rate. Having a predetermined time to load, the strain rate can be read off the nomograph.

For example, testing an aluminum alloy with a modulus of 10,000,000 psi. and a yield strength of approximately 40,000 psi., the stress line numbered 40, running vertically from the bottom right-hand section of the nomograph, is followed to its intersection with the 10×10^6 modulus (slanting line). This intersection comes eight horizontal grid lines from the base. Assuming it is desirable to pull this specimen in 8 sec., follow the horizontal grid line to the left to intersect the 8-sec. curve and thence down to base to read on the log scale, 0.0005 in. per in. per sec.

Using the same conditions but assuming that a rate of 0.001 in. per in. per sec. is desired, the same horizontal grid line is traced until it intersects the vertical line 0.001 in. per in. per sec. and the time is read from the nearest time curve, or 4 sec. time to lapse from no load to 40,000 psi. load. When testing at elevated temperatures and using the nomograph to determine strain rate or time, the modulus of the material *at the test temperature* should be used.

*Metallurgist, Materials and Processes, Convair, Pomona, Calif.

AFTER FORMING 10,000 STAINLESS STEEL SHEETS THIS DUCTILE CAST IRON DIE SHOWS...



Ductile Cast Iron Die (flame-hardened) used to draw and form stainless steel sheets for inside and outside parts of milk and cream dispensers. Its strength and toughness give it good die characteristics. "Built-in-lubrication" — supplied by spheroids of graphite — resists galling and pickup, keeps critical surfaces smooth and blemish-free. Dies cast by Prospect Foundry Company for Norris Dispensers, Inc., Minneapolis, Minn. For full particulars on the use of Ductile Cast Iron for stamping and drawing carbon steel, stainless steel or aluminum, just write us.

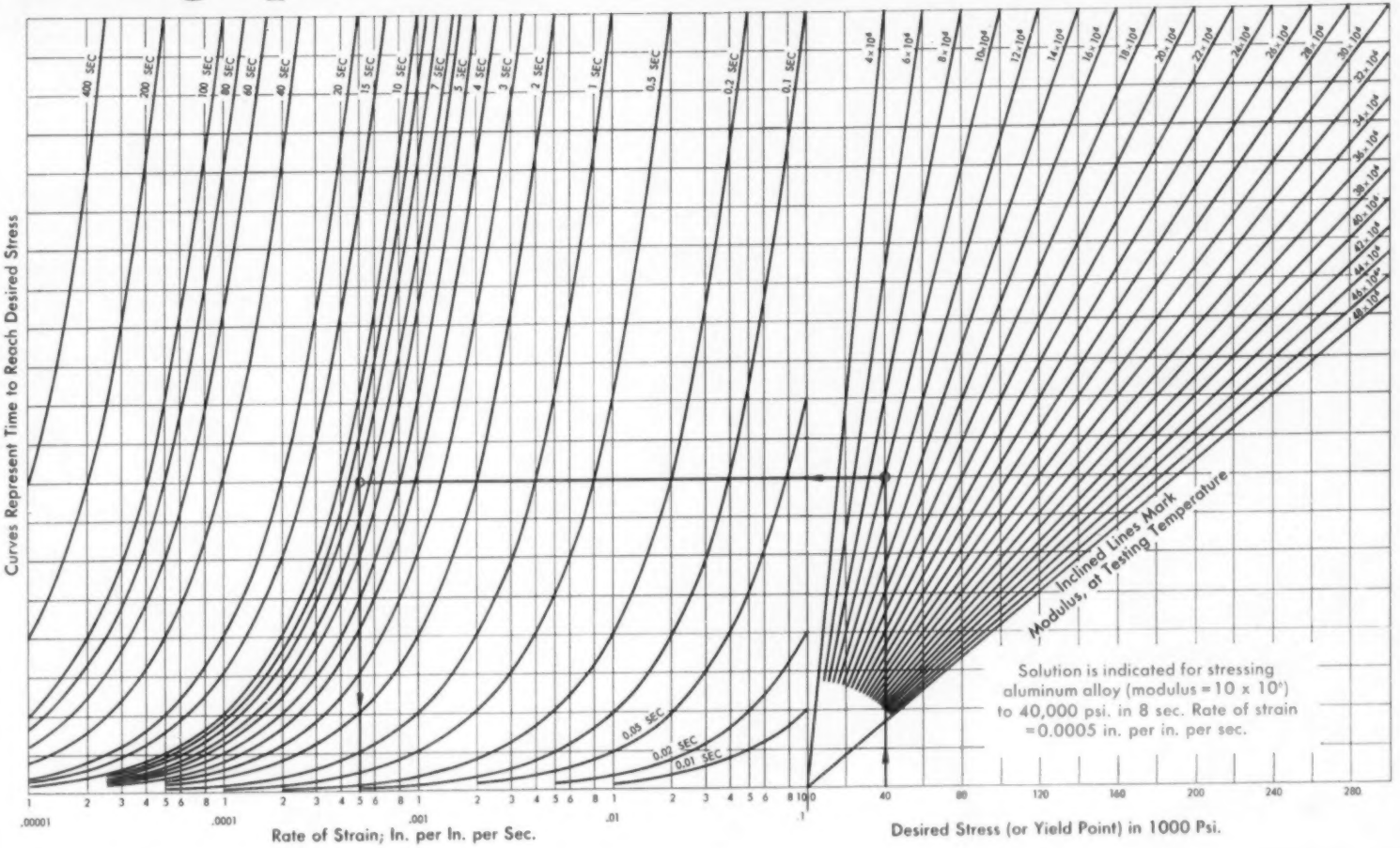
No Galling
No Chipping
No Cracks
No Metal Pickup
No Polish Loss
No Maintenance

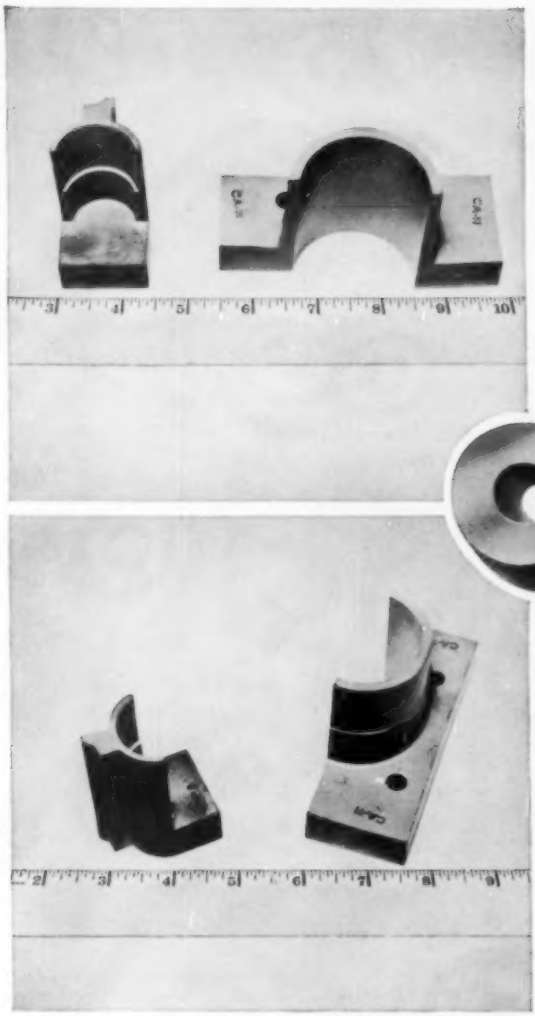
THE INTERNATIONAL NICKEL CO., INC.
67 Wall Street New York 5, N. Y.

ductile iron...the cast iron that can be twisted and bent.

Nomograph for Rate of Strain

By W. H. Mather





Look How You Can Save with PREFORMED CARMET®

DIE SECTIONS

these Blanks are preformed to a Finishing Allowance of .018"-.022" per side



Write for Your Copy:
CARMET CATALOG

Just out . . . 32 well-illustrated pages, containing data on all Carmet grades, and on Carmet blanks, tools, die sections, punches, draw die inserts, etc.; also special preforming to order. ● *Write for your copy.*

ADDRESS DEPT. MP-93

These tungsten carbide die sections are of Carmet CA-11, a special grade developed expressly for punches, dies, and other heavy shock applications where wear and abrasion resistance are required.

These blanks have a span of 1.315" with a wall thickness of only .046", but they were easily produced to close tolerances by AL's precision preform methods. All surfaces are clean, smooth and free from defects, requiring only a minimum amount of grinding to final dimensions.

Carmet carbides can be accurately produced to practically any shape or size your designs may require, and can be supplied preformed as desired. Typical highly successful applications include inserts for drawing, heading, extruding and blanking dies; gauge and wear parts; pins; bushings; etc.

Find out, TODAY, how you can cut costs with preformed Carmet. Write or call *Allegheny Ludlum Steel Corporation, Carmet Division, Wanda and Jarvis Avenues, Detroit 20, Mich.*

For nearest representative, consult Yellow Section of your telephone book.

For ALL your CARBIDE needs, call
Allegheny Ludlum
WSW 6636

AL® FINE TOOL STEELS SINCE 1854

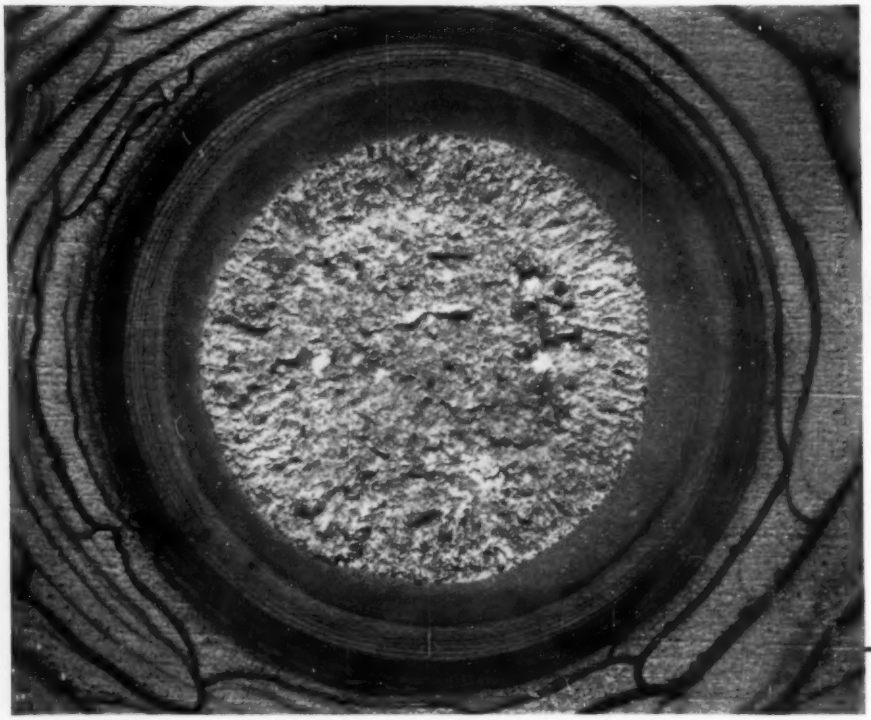
Bausch & Lomb Salutes:

Charles A. Fournier

. . . Blue Ribbon Award Winner, 1955, A. S. M. Metallographic Exhibit



BLUE RIBBON AWARD WINNER for best photomicrograph in the *Welds and Other Joining Methods* Class —Mr. Charles A. Fournier, Ford Motor Company, Aircraft Engine Div., Chicago, Ill.



HIS AWARD-WINNING PHOTOMICROGRAPH, MADE WITH BAUSCH & LOMB EQUIPMENT
"Interfacial Defects at the Outer Periphery of Resistance Spot Welds in Type-410 Stainless Steel."

Bausch & Lomb metallographs help industry boost output and maintain quality by providing detailed magnified images—visual or photographic, for routine work and advanced research.

The Model L Photomicrographic Equipment is a versatile example of the complete B&L metallographic line. It provides ease, speed and efficiency in visual microscopy . . . high power photomicrography . . . photomacrography . . . and photocopying—with transmitted or reflected light. A complete photomicrographic department in one compact unit.



Find out how these faster, easier, completely dependable analyses can help you save on time and materials. Write for Catalog E-210, and for complete expert advisory service. No obligation, of course.
Bausch & Lomb Optical Co., 63821 St. Paul St., Rochester 2, N. Y.

America's only complete optical source . . . from glass to finished product.

BAUSCH & LOMB
SINCE B&L 1853

Two Promising New Titanium Alloys

*By S. ABKOWITZ and DILLON EVERS**

An alloy with 2.5% Al and 16% V is readily formable and then age hardened to 160,000 psi. yield strength retaining 5% elongation. An alpha alloy with 8% Al, 2% Cb and 1% Ta is weldable in bar and sheet form and extends the temperature limit of usefulness 200° F. over conventional alpha alloys. (Q23q, Q27a, Q3m, 2-12, 2-14; Ti)

MORE STRINGENT requirements of the users of titanium alloys have resulted in extensive work by producers to improve the existing materials. The task is not easy, because any new alloy must not only be made consistently in commercial quantities and sizes but also to possess diverse fabrication characteristics and mechanical properties. Formability, weldability, high strength, and creep resistance at elevated temperatures seem to be the attributes generally desired.

Creep resistance can be improved by alloying elements which stabilize the alpha phase. Aluminum is the element most used for this purpose. It increases creep resistance and does not impair weldability. While such alpha-stabilized alloys are more difficult to form, and the strength and formability of these single-phase alloys cannot be improved by heat treatment, they are well worth consideration when weldments and resistance to stress at elevated temperatures are desired.

Much better formability can be obtained in alloys which can be solution treated to retain the beta phase. They are then aged sufficiently so as to be greatly strengthened by partial transformation into the alpha phase. Many beta stabilizers are in use – vanadium, molybdenum, chromium, iron and manganese. A major difficulty with many present alloys of this sort is that they lose their strength and creep resistance rapidly as their temperature is increased. Also, because these two-phase alloys respond to heat treatment, they become embrittled by welding.

The purpose of this paper is to discuss the characteristics of two new titanium alloys which

*Mr. Abkowitz is supervisor of alloy research and Dr. Evers is manager of research, Mallory-Sharon Titanium Corp., Niles, Ohio. Based on work done by P. E. Moorhead and A. L. Klibanoff, research metallurgists.

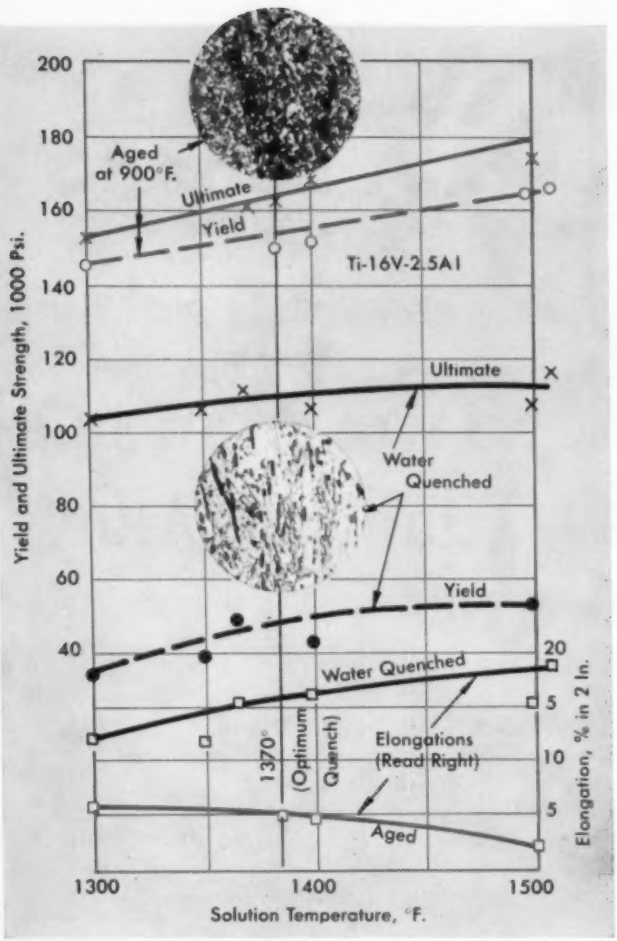


Fig. 1 — Tensile Properties of Titanium Alloy Containing 2.5% Al and 16% V After Solution Treatment (Black Lines) and After Aging (Red Lines). Typical microstructures are shown for the optimum quenching temperature, 1370° F. Samples held 20 min at solution temperature and water quenched. Subsequent aging was for 24 hr. at 900° F., followed by air cooling

Mallory-Sharon Titanium Corp. is introducing in 1957 for evaluation by its customers. The data result from research over a period of two years on many 100-lb. laboratory ingots; the corresponding data on production ingots weighing 3000 lb. are in general agreement with those from laboratory ingots.

Vanadium-Aluminum Alloy

The first alloy to be described here (MST 2.5Al-16V, having 2.5% Al, 16% V, bal. Ti) contains both an alpha and a beta stabilizer and we believe has some of the best characteristics of the two main types. Studies started after receiving many requests from the airframe industry for a sheet alloy which would be soft and formable in the solution treated condition and which could be aged, after forming, to high strength while still retaining usable ductility. MST 2.5Al-16V is a highly beta-stabilized alloy which, as will be shown later, has very attractive properties in the solution treated condition, namely a tensile strength as low as 110,000 psi., a yield strength of 50,000 psi. with 16% elongation and minimum bend radius of 1 to 2 T's. Subsequently it can be aged to a tensile strength of 170,000 psi. and a yield strength of 160,000 psi., and will still retain 5% elongation.

Inasmuch as this alloy is to be formed in the solution treated condition and used in the age hardened condition, properties in both conditions are important. However, the solution treatment which produces the best formability does not necessarily produce the best properties after subsequent aging.

Solution Treatment Temperatures — Figure 1 illustrates the effect of solution temperature on the properties both of solution treated and of hardened 0.040-in. sheet. The black lines represent as-quenched material, solution treated between 1300 and 1500° F. Both the ultimate and yield strengths increase slightly with increasing solution temperature, maintaining their rather constant difference of about 60,000 psi. Solution temperature has a much more pronounced effect on elongation; although 1450° to the ductility of solution treated sheet, it does F. is above the beta transus, the ductility of the solution treated material continues to increase. Thus there is no indication of beta embrittlement of this alloy.

The plots and lines in red show the properties of these solution treated alloys after aging at 900° F. for 24 hr. Increasing the solution temperature increases the ultimate and yield strengths markedly but decreases elongation from a high of 6% for the alloy solution treated at 1300° F. to a low of 2% for the alloy solution treated at 1550° F. Thus, although quenching from above the beta transus is not detrimental

decrease the ductility after age hardening. Quenching from a temperature in the alpha-beta field (1350 to 1400° F.) is therefore desirable for an optimum combination of properties after solution treatment and after aging. 1370° F. was adopted as the optimum temperature during this research.

Microstructures of this alloy in both the solution treated and the age hardened conditions, after etching in 10% HF, 5% HNO_3 solution, are shown in the inserts in Fig. 1 at 500 ×. The microstructure of this sheet, as water quenched from 1370° F., consists of residual alpha islands in a beta matrix with some alpha-prime. On aging, the microstructure darkens, probably from the precipitation of irresolvable particles of alpha phase, resulting in a structure of residual alpha and transformed beta in a beta matrix.

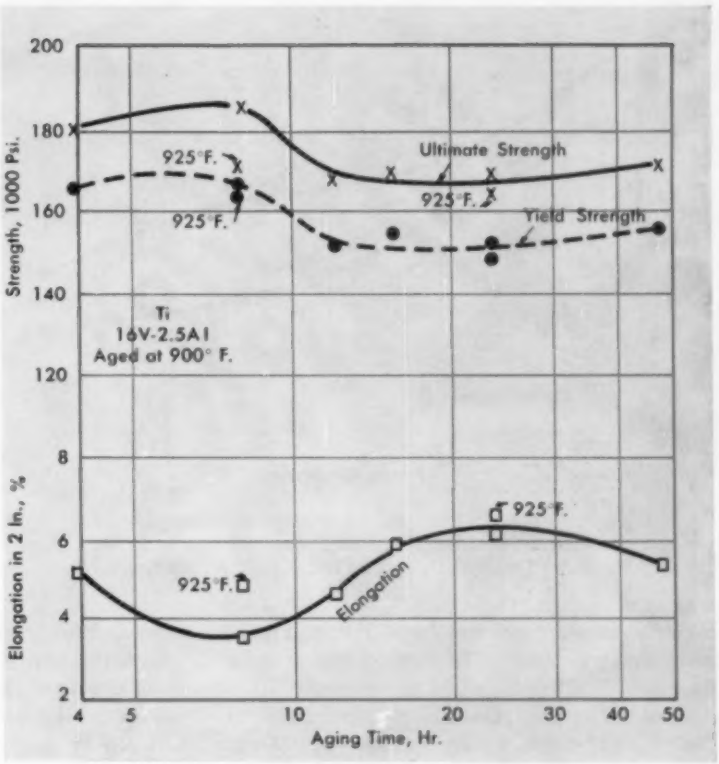


Fig. 2 – Effect of Aging Time on Strength and Ductility of MST 2.5Al-16V After 20 Min. at Solution Temperature of 1370° F. and Water Quenching. Aging temperature 900° F., except as noted

Quenching Mediums – The effect of cooling rate on the tensile properties of the solution treated alloy is shown in Table I. There is a large difference between the ultimate and the yield strengths after all quenches investigated, the spread between the two becoming greater as the cooling rate increases. Satisfactory tensile ductility is obtained with all cooling rates equal to or greater than that in boiling water.

Parallel columns in the table illustrate the fact that elongation of sheet samples, aged 24 hr. at 900° F., is not greatly affected by cooling rate; the range is 3.7 to 4.9%. Highest *strengths* in aged samples can be obtained by air cooling or water quenching from solution temperatures, but since air cooling produces low ductility in the solution treated sheet, water is the optimum coolant.

Aging temperature and time were investigated and the results are summarized in Fig. 2. The

Table I – Effect of Cooling Rate From Solution Temperature on 2.5Al-16V

Quench	As Quenched★			Aged†		
	Ultimate	Yield	Elongation‡	Ultimate	Yield	Elongation‡
Air	108,300	63,400	6.6	185,300	172,900	3.9
Boiling water	97,200	34,500	20.4	162,600	150,000	4.7
Oil	96,200	52,200	14.2	167,500	155,600	4.9
70° F. water	97,300	37,500	18.2	176,200	156,000	4.6
Brine	98,800	35,900	15.6	160,500	152,500	3.7

★Held 20 min. at 1370° F. and quenched as shown.
†Aged 24 hours at 900° F., air cooled.
‡% in 2 in.

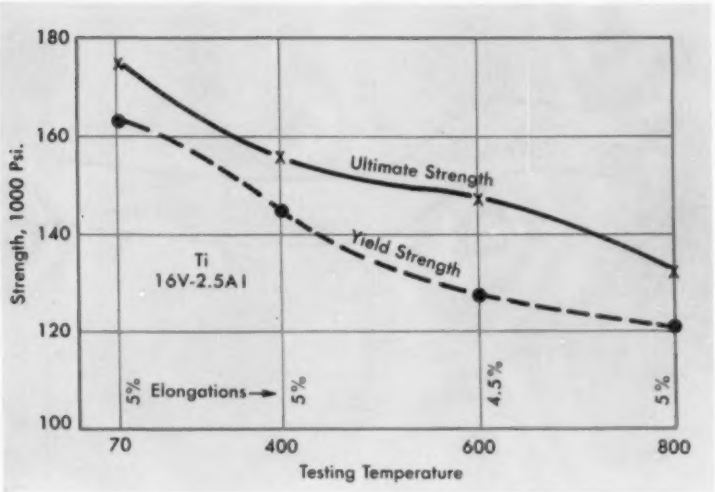


Fig. 3 – Short-Time High-Temperature Strength of MST 2.5Al-16V Sheet, Solution Treated 20 Min. at 1370° F., Water Quenched, Aged 24 Hr. at 925° F., Air Cooled

curves represent conditions for 900° F. and times between 4 and 50 hr. The data for two samples aged at 925° F. for 8 and 24 hr. respectively fall close to the curves. One sample aged 20 hr. at 1100° F. was much weaker (about 130,000 psi. ultimate) but more ductile (about 7.5% elongation). Aging temperatures between 900 and 1000° F. for 4 to 24 hr., corresponding to the flat portion of the curves in Fig. 2, appear useful.

High-Temperature Strength – Figure 3 indicates that age hardened sheet has good short-time hot strength up to 800° F. At 800° F., the yield strength is approximately 120,000 psi.; above 800 the strength decreases rapidly. Elongations are close to 5% in all tests up to 800° F.

Thermal Stability and Creep – This 2.5% Al, 16% V alloy, in the form of age hardened bar, was subjected to a load of 50,000 psi. at 800° F. for 165 hr. Under these severe creep conditions, the bar elongated 4.8%. The room-temperature tensile properties of the bar before and after creep exposure are as follows:

Property	Original	After Creep Testing
Ultimate	166,000 psi.	173,700 psi.
Yield (0.2% offset)	150,700 psi.	167,700 psi.
Elongation in 1 in.	12.5%	9.0%
Reduction in area	50.7%	32.7%

These results indicate satisfactory thermal stability, but low creep resistance at 800° F. and 50,000 psi. At temperatures below 700° F. and stresses below 40,000 psi. creep deformation of less than 1% in 150 hr. may be expected. This is close to half the yield strength as recorded in the short-time tensile test (Fig. 3).

Other Properties – The effect of strain occurring after solution treatment and before aging on the aged properties was investigated. Solution treated specimens were quenched and then strained 0, 5, 10 and 13% in tension. There was no appreciable difference in properties between the unstrained and strained sheet after aging.

The notched tensile properties of bar in the age hardened condition indicate a ratio of notched to unnotched tensile strength of 1.2 to 1.4 for a stress concentration factor, K_t, of 3.8.

The density of this alloy containing 2.5% Al and 16% V is 0.168 lb. per cu.in.—comparable to other commercial titanium alloys.

In view of the above evaluation, this alloy seems to have considerable promise as sheet for applications primarily requiring a combination of severe forming capability and high aged strength. It is one of the alloys currently under study in the Department of Defense's sheet rolling program.

All-Alpha Alloy "MST 821"

The second alloy, an all-alpha type, was developed as a weldable sheet and bar alloy for use at high temperature. It has been designated "MST 821" and contains 8% aluminum, 2% colum-

Table II – Typical Properties of Annealed MST 821

	0.040-In. Sheet*	⅝-In. Bar†
Tensile strength	127,000 psi.	130,000 psi.
Yield strength, 0.2% offset	120,000 psi.	123,000 psi.
Elongation	16.0% in 2 in.	16.0% in 1 in.
Reduction of area		38.0%
Minimum bend radius, T_R	3.5 to 4.0	
Charpy impact		25.0 ft-lb.
Modulus of elasticity	17×10^6 psi.	17×10^6 psi.
Density	0.158 lb. per cu. in.	

*Annealed 20 min. at 1650° F., air cooled.
†Annealed 1 hr. at 1650° F., air cooled.

bium, 1% tantalum, balance titanium. Tantalum and columbium in small quantities permit higher tolerance for aluminum than any other alloying element. At the same time tantalum is an almost neutral solute (in the sense of having little influence in stabilizing either the alpha or beta phases) while columbium stabilizes beta very slightly. Both elements have but small influence on heat treatment or hardenability; thus, the MST 821 alloy is ductile after welding.

The typical properties of this alloy as both annealed sheet and bar are shown in Table II. Satisfactory strength is obtained by substitutional elements rather than by a high oxygen content. The sponge used in making this alloy has 120 Brinell hardness; however, the strength of this alloy is greater than that of MST 5Al-2.5 Sn (5% Al, 2.5% Sn, bal. Ti) using sponge of 160 Brinell hardness. Thus we have a medium strength alloy containing 8% aluminum with good tensile and bend ductility. In welding tests it retains its original strength and bend ductility. Such welding tests on sheet have been carried out at a research institute and by aircraft manufacturers; the alloy's as-welded bend ductility (average 5 T$_s$) appears comparable to that of the commercial alloy containing 5% Al and 2.5% Sn.

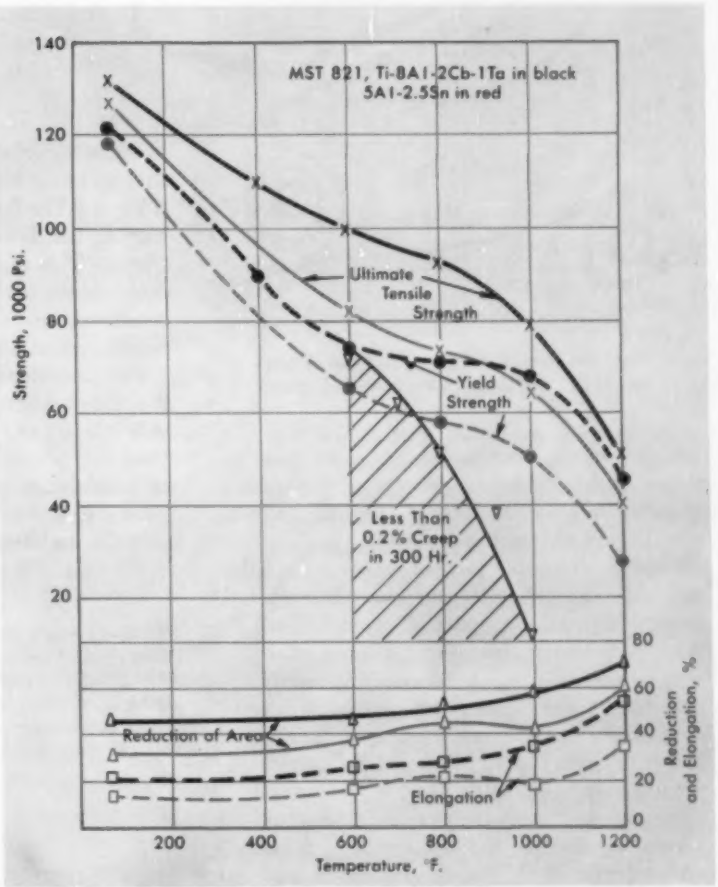


Fig. 4 – Black Lines Show Short-Time High-Temperature Tensile Strength (and Also Creep Strength for 0.2% Elongation in 300 Hr.) of 8Al-2Cb-1Ta. The red lines compare tensile data for Ti-5Al-2.5Sn

High-temperature short-time tests of these two are compared in Fig. 4, where the new alloy is shown in black lines and MST 5Al-2.5 Sn in red lines. The new alloy Ti-8Al-2Cb-1Ta has approximately a 200° F. advantage for equal strength in the range from 250 to 850° F. Ductility (reduction of area and elongation values) also is excellent.

These short-time tests are only one measure of high-temperature performance. The hatched area on Fig. 4 gives some creep properties of the new alloy. At temperatures up to 800° F., times up to 300 hr., and stresses up to 50,000 psi., the total plastic creep of this alloy is 0.2% or less. Even at 1000° F. and 10,000 psi. this alloy had only 0.2% creep. Properties before and after creep testing at 800° F. and 60,000 psi. for 500 hr. are:

Property	Original	After Creep Testing
Ultimate strenth, psi.	135,000	150,000
Yield strength, psi. (0.2% offset)	124,000	142,000
Elongation in 1 in., %	18.0	18.5
Reduction of area, %	45.0	31.0

The new MST 821 alloy, unlike a Ti-8Al binary alloy, is thermally stable at elevated temperatues. The latter is embrittled by exposures in the range of 1000 to 1100° F. MST 821 has over 12% elonga-

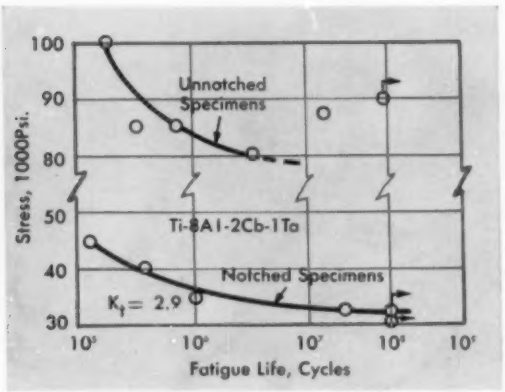


Fig. 5 – Rotating Beam Fatigue Tests on MST 8Al-2Cb-1Ta Annealed Bars

tion and 27% reduction of area after long exposure to these same temperatures. It has been subjected to stress at 1000° F. for 300 hr. with little damage to tensile ductility.

Figure 5 shows the fatigue properties of alloy MST 821. The alloy has an unnotched endurance limit at 108 cycles of about 60% of its ultimate tensile strength. Its notch sensitivity index is 0.5, which compares favorably with that of the alpha alloy containing 5% Al and 2.5% Sn. The notch toughness of the alloy is indicated by its good Charpy impact strength shown in Table II.

The preferred annealing cycle for sheet is 20 min. at 1650° F. and air cooling. This produces the same tensile properties and structure as a furnace cool, but better bend ductility. Bar is annealed at 1650° F. for 1 hr. or longer, depending upon section size.

The elements tantalum and columbium do not produce any appreciable response in heat treating bar and heavy-gage sheet. Nevertheless, thin sheet (0.040 in. or less) can be age hardened. Figure 6 shows the effect of solution temperature on the properties of both solution treated and age hardened MST 821. By quenching from temperatures high in the alpha-beta field (1850° F.) and aging, a yield strength of 150,000 psi. is achieved with satisfactory ductility. The alloy must be quenched without delay, since air cooling tends to stabilize the alloy.

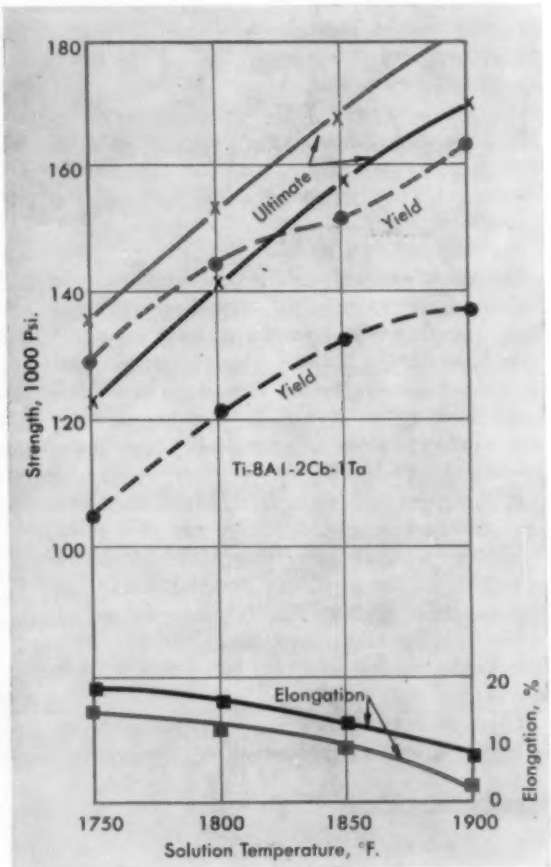
The beta transus of this alloy is approximately 1920° F., which means that high solution treating temperatures are required. On the other hand, this high beta transus permits high forging and extrusion temperatures without beta embrittlement (an important criterion for an extrusion alloy).

Typical annealed structure is essentially all alpha with small scattered beta islands. Typical age hardened structure shows beta islands (darkened by action of etchant) in an alpha matrix.

With 8% aluminum in the alloy the modulus of elasticity (about 17×10^6 psi.) is higher than that of other commercial alloys and its density is lower. The density of MTS 821 is 0.158 lb. per cu. in., the lowest of all commercial titanium alloys. This indicates that the strengths previously shown for the annealed and age hardened conditions are even more advantageous when considered on a strength-weight basis.

The combination of properties indicated by the above described work has caused considerable interest and intensive evaluation both in our plant and in customers' shops. The combination of weldability with high-temperature strength, good ductility and formability, topped with high modulus and low density is one definitely needed in the titanium industry.

Fig. 6 – Tensile Properties of 0.040-In. Titanium Alloy Sheet Containing 8% Al, 2% Cb and 1% Ta after Solution Treatment (Black Lines) and After Aging (Red Lines). Samples held 20 min. at solution temperature and water quenched. Subsequently aged 8 hr. at 900° F., then air cooled





Book Review...

Humanity and the Atom

*Reviewed by ERNEST E. THUM**

ATOMIC QUEST, A PERSONAL NARRATIVE, by Arthur Holly Compton. Oxford University Press, New York, 370 p., $5.

THIS IS THE TYPE of book, and may there be many others, which puts some flesh on the bare bones of the so-called Smyth Report† – in itself a carefully screened condensation of a still-secret document several times larger. Professor Compton is the Nobel prize-winning investigator of X-rays and cosmic rays and as such was one of an international group of savants who had long been studying radioactivity and atomic structure. For them Fermi's discovery in 1934 of a remarkable effect of neutrons on uranium atoms and the later discovery of atomic fission were events of surpassing importance. The American-born physicists were intrigued with the possibility that the resulting energy might be useful for a power source; foreign-born physicists living here (as well as English scientists) dwelt upon the possibility of an enormous explosive. It was the latter, of course, which was responsible for the war-time "crash program", and this book describes the part the author played in it as chairman of the physics department of the University of Chicago.

Space does not permit even an outline of the book. Compton's part in the atomic quest initially was to discover whether it is possible to produce a "chain reaction" in natural uranium, and this in turn led to the manufacture of the new explosive metal plutonium formed during such a reaction. Plutonium, at the time, was a theoretical substance; later, microscopic amounts were made by bombarding uranium with neutrons in the cyclotron in Ernest O. Lawrence's radiation laboratory at Berkeley. Then work in John R. Dunning's laboratory at Columbia University indicated that one neutron, causing one uranium atom to fission, would thereby produce more than two new neutrons – hence the possibility of a chain reaction with one of them and the production of an atom of plutonium with the other. At Compton's suggestion, Volney C. Wilson reported in the summer of 1940 that a nuclear chain reaction could be produced in natural uranium. Compton became a member of S-1 (code for "National Defense Research Committee, Uranium Section") on its organization the very day before Pearl Harbor, with orders to do everything possible to find out whether atomic bombs could be made and if so how soon.

His personal influence in the Metallurgical Laboratory at Chicago University, where the first chain reaction was achieved almost exactly a year later (Dec. 2, 1942) and all the auxiliary work which led to the pilot plant in Oak Ridge and the producing reactors in Hanford was great, not only as a leader in originating necessary work but in finding men capable of doing it. When large and complex activities started at Oak Ridge, he decided it was too much for a distant university staff to supervise, so work at Oak Ridge was transferred to Monsanto Chemical Co. Du Pont also took over design, construction and operation at Hanford. Compton, however, was in direct charge of the work on the Chicago campus and that transferred to Argonne Laboratory in Cook County Forest,

*Editor, *Metal Progress*.

†"A General Account of the Development of Methods of Using Atomic Energy for Military Purposes Under the Auspices of the United States Government, 1940-1945", by H. D. Smyth, written at the request of Maj. Gen. L. R. Groves, U. S. Army.

some 30 miles west – much of it having to do with the separation of pure plutonium from the mother uranium and the highly radioactive fission products. Compton's duties on top-level planning committees continued throughout World War II.

The whole story is one of extraordinary co-operation of free men, each doing his part, minor or major, to the best of his ability. He notes that, in studies of methods of producing plutonium, about 5000 laboratory workers were engaged in more than 70 locations. Yet the individual was not lost. For example, it was not a major laboratory but a little group with Frank Spedding at Ames that discovered how to reduce pure uranium by the ton.

Also in the largest of organizations, the individual American is indispensable. Hanford reactors almost failed because a new phenomenon appeared, not evident in the pilot plant. Fortunately the structures were over-designed to take an over-load of uranium – just in case – as is commemorated in the ballad of "Old Marse George":

The tale's been told, as well you know,
That Hanford nearly flopped, although
The piles were later made to go
  Through brilliant engineering.

The reason they were made to run
Was that a battle had been won
Long months before, in Wilmington,
  With brains and persevering.

We'd cobbled up a tight design
Hewn strictly to the longhairs' line.
To us it looked almighty fine –
  A honey, we'd insist.

But Old Marse George, with baleful glare
And with a roar that shook the air
Cried, 'Dammit, give it stuff to spare –
  The longhairs may have missed!'

For days on end we fought and fit
With all our might and all our wit;
But George, he yielded not a bit –
  At last he had his way.

And later, when the crisis came
'Twas George's trick that saved the game;
And thrice we bowed, and praised his name
  From dusk to dawn that day.

With Nagasaki smoking hot,
The news was full of tommyrot;
And generals and colonels got
  A lot of decorations.

Of Old Marse George you never heard
A single solitary word
And quietly we gave the bird
  To all the celebrations.

Regardless of his rank or state,
One man can sway a nation's fate
When crises come, the hour is late
  And stakes are mighty large.

In days of bitter crisis, when
The country calls for valiant men
We pray there may arise again
  The like of Old Marse George.

Marse George was truly only one of numberless other unsung heroes of wartime.

Woven through the text are many paragraphs discussing the moral aspects of bomb-making, as would be natural for a man of his unbringing. Compton's father was an ordained Presbyterian minister. His mother was a Mennonite – pacifism was to her a fundamental doctrine. He himself holds that war is essentially immoral. Yet he felt that there are things in the world more important than his own life, and he could not accept the proposition that war is *always* the wrong course of action. After the Japanese attack on Pearl Harbor he decided that he had to take part in the great struggle to prevent dictatorship from engulfing the world. This soul searching was not uncommon among the thousands of men who worked on the bomb. It should be remembered by those who so glibly (like the columnist I read only yesterday) blame them for the ghastly bomb "the scientists have made".

Also a long chapter entitled "Hope" gives his appraisal of the future chances of avoiding World War III – the ultimate catastrophe. Starting from the christian's view that man has inherent value, he believes that freedom to exert that value to the advantage of himself, his neighbors, and the world at large is the ultimate aim of civilization. To achieve this, in the face of totalitarian and communist opposition, he believes it is necessary for free men to do three things: *first*, maintain an adequate defense; *second*, develop all parts of the world economically and culturally; *third*, reach a common agreement among all free men as to the indispensable purpose of human life – achieving an even greater degree of freedom – an agreement so wholehearted and firm that everyone will fight for it, if need be.

There are some things that are more valuable than life.

Superpurity Nickel Melted Under Controlled Atmospheres

*By K. M. OLSEN**

Research work on vacuum-tube "repeaters" for transoceanic cables requires nickel of unexampled purity. This can be made by melting sintered slugs of carbonyl nickel powder in magnesia crucibles under a definite program of hydrogen, vacuum and helium atmospheres. The process is also effective for high-purity binary nickel alloys and iron alloys. (C5j; Ni-a)

In research on the life and performance of vacuum tubes for submarine cable repeaters, it became apparent that considerable quantities of nickel and high-nickel alloys would be required of purity much beyond the metal then available. Nickel and its alloys containing controlled single additions of magnesium, aluminum or tungsten were needed for experimental cathode structures in long-life vacuum tubes. These cathodes are coated with barium and strontium oxides. It was known that impurities in the base nickel influenced the formation of free barium in these coatings and hence changed the emission characteristics. Impurities also seemed to contribute to the formation of a high-resistance layer at the coating-nickel interface.

Since the impurities involved were in the range of 0.01 to 0.1% it was apparent that a nickel of superior purity would be required in order to determine the effects attributable to each added element.

Nickel of really high purity is difficult to prepare by conventional melting and casting because of contamination from the crucible and the necessity of adding deoxidizers to produce a sound ingot. A survey of the available high-purity raw materials resulted in the selection of carbonyl nickel powder made by the Mond Co. of England. Through the cooperation of the International Nickel Co., two 1000-lb. lots of selected powder were secured, with typical impurities of 0.004% Fe, 0.001% Mg, 0.001% Al, 0.001% Cu, 0.001% Si, and others less than

*Metallurgical Research Dept., Bell Telephone Laboratories, Inc., Murray Hill, N.J. The author wishes to express appreciation to D. H. Wenny, Jr., for his guidance and encouragement of this work, to P. H. Schmitt, Jr., for his help in carrying out the experimental melting program, and to Miss B. Prescott, E. K. Jaycox, D. Babusci, W. G. Guldner, A. L. Beach, H. E. Johnson, and F. M. Ryan for the necessary analytical work.

0.001%. The high oxygen (0.2%) and carbon (0.07%) contents were not objectionable since they could be driven to a satisfactory low level by hydrogen reduction.

Since we had previously prepared high-quality soft magnetic alloys without the use of deoxidizers by controlled atmosphere melting, we used this type of furnace (Fig. 1 and 2). It is so equipped as to permit melting and casting in wet or dry hydrogen, in inert atmospheres, under partial or atmospheric gas pressures, under continuously flowing atmospheres, under vacuums of about 1 mm. Hg, or under any desired sequence. Past experience had also indicated that minimum contamination from the crucible might be expected from a prefabricated magnesium oxide crucible (Norton Co., Type 4473, 96% min. MgO).

Sound Ingots – We first tried melting compressed bars of the carbonyl nickel powder. Melting under hydrogen, vacuum, helium, argon, and various sequences all resulted in a gassy ingot, as shown at the left of Fig. 3. Remelting after freezing in the crucible to release dissolved gases did not help. We were able to prepare a sound ingot by melting the pressed bars in air to burn off the carbon, then reducing the oxide in the molten nickel by a dry hydrogen treatment, and finally pouring under helium. Subsequent processing gave us scaled and blistered strip indicating much oxide remaining in the metal. Nevertheless, this indicated that sound ingots could be prepared if the carbon content were reduced to sufficiently low levels.

Melting of uncompacted carbonyl powder under a dry hydrogen atmosphere gave better results. While completely sound ingots were not obtained, the carbon was being more effectively removed by the better diffusion of hydrogen through the powder and by the exposure of a greater surface area to the reducing gas.

Soundness was further improved through the use of nickel slugs produced by slowly sintering the carbonyl powder in wet hydrogen at low temperature. The following procedure was finally adopted for preparing sound ingots (as shown in Fig. 3, right) capable of processing into satisfactory strip:

1. Slugs pressed of carbonyl nickel powder were sintered in a magnesium oxide container by heating 12 to 16 hr. at 1475° F. (800° C.) in wet hydrogen. This reduced the carbon content from 0.07 to about 0.007%.

2. The sintered slugs were charged into the

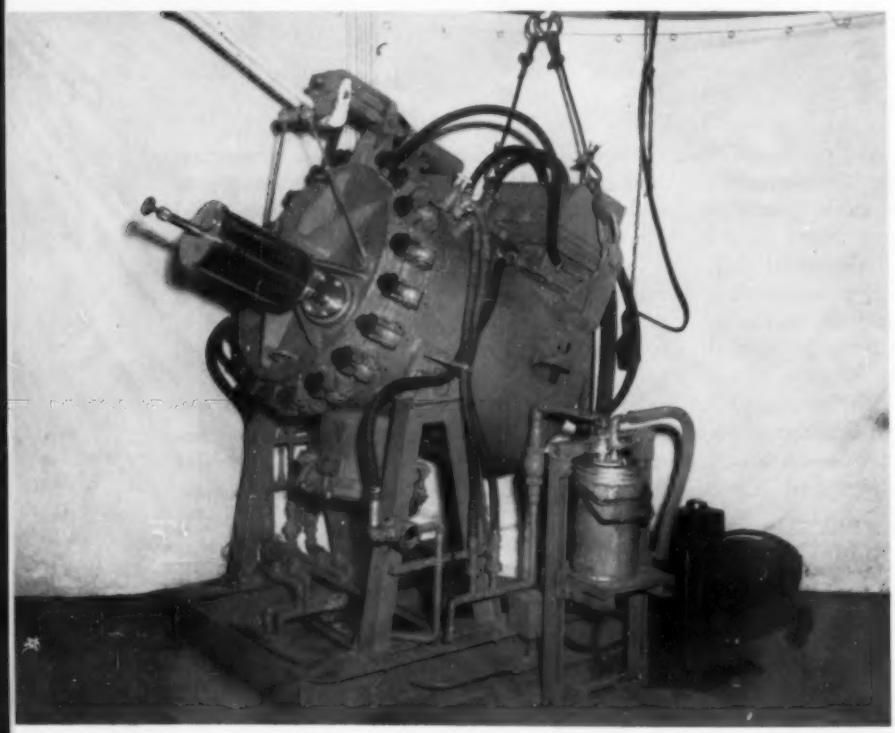


Fig. 1–View of Furnace (Tilted to Casting Position) for Melting and Casting 26-lb. Ingots Under Controlled Atmosphere or a Vacuum.

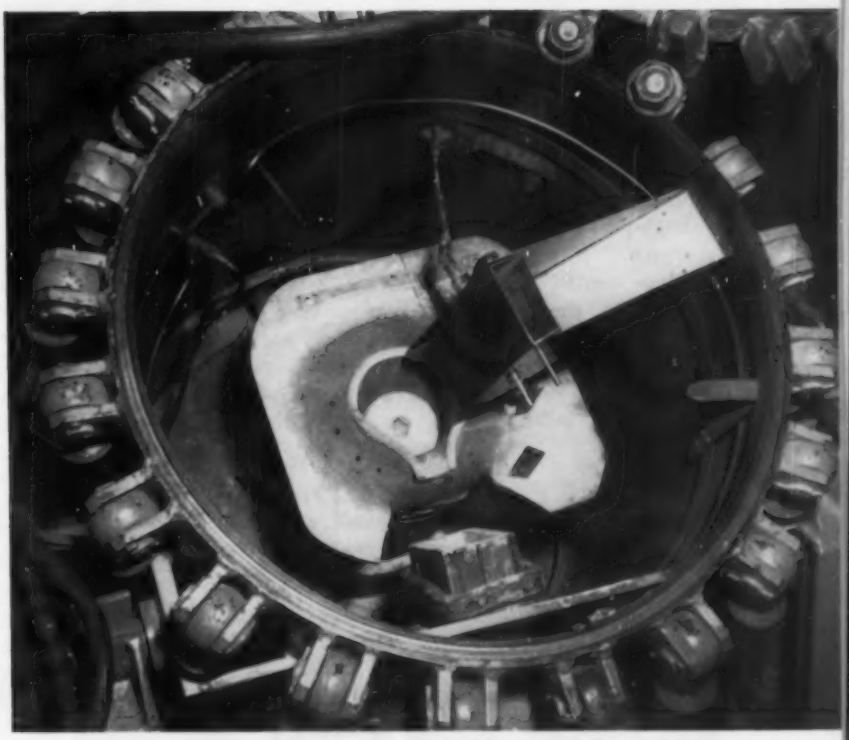


Fig. 2–View of Furnace Interior (Cover Removed). Note central crucible within induction coil, bin and chute for additions, top of ingot mold just below pouring lip.

magnesium oxide crucible, the alloying agent placed in the addition hopper, and the melting furnace closed.

3. The system was evacuated to about 1 mm. pressure. Dry hydrogen (dew point approximately –20° F.) was introduced until a steady flow of 20 cu.ft. per hr. at 1 atm. pressure was reached.

4. The charge was heated inductively using a 1920-cycle, 450-volt, 100-kw. generator. Melting under the flowing dry hydrogen atmosphere began in about 40 min. and complete melt-down occurred about 20 min. later. The molten charge was held for an additional 10 min. in dry hydrogen to insure complete miscibility and to reach a stable temperature.

5. The dry hydrogen was purged from the system with dry helium, taking approximately 10 min.

6. Gases were removed from the system by evacuation to about 1 mm.

7. Dry hydrogen was reintroduced and held for 15 min. to reduce as much carbon and oxygen as possible.

8. The system was flushed with dry helium (10 min.).

9. Gases were evacuated.

10. Dry helium was reintroduced into the system.

11. The molten charge was poured under dry helium (1 atm. pressure) at approximately 2730° F. (1500° C.) into an alundum coated steel mold.

The entire furnace container and crucible were kept dry and gas-free during inoperative periods by maintaining the system under vacuum while continuously passing warm water through the induction coil.

The 26-lb. ingots were hot rolled in air at 1830° F. (1000° C.) to ½-in. plate, the surfaces machined to remove oxide scale, and cold rolled to 0.020-in. strip with one intermediate anneal at 0.080 in. in hydrogen at 1475° F. (800° C.). Sample lengths were re-annealed and rolled further to 0.003 in. The annealing was done continuously by passing the strip through a heated Inconel muffle at about 1.5 ft. per min., the heating zone being about 3 ft. long. The pure kerosene used as a rolling lubricant was carefully removed prior to each anneal.

Spectrographic analysis of the materials showed that practically no impurities were picked up during melting and fabricating as described.

Purity and Properties

Nine 26-lb. ingots were cast and rolled into strip. Their nominal compositions were:

High-purity nickel with no additions.

High-purity nickel with 0.003, 0.03 and 0.1% magnesium.

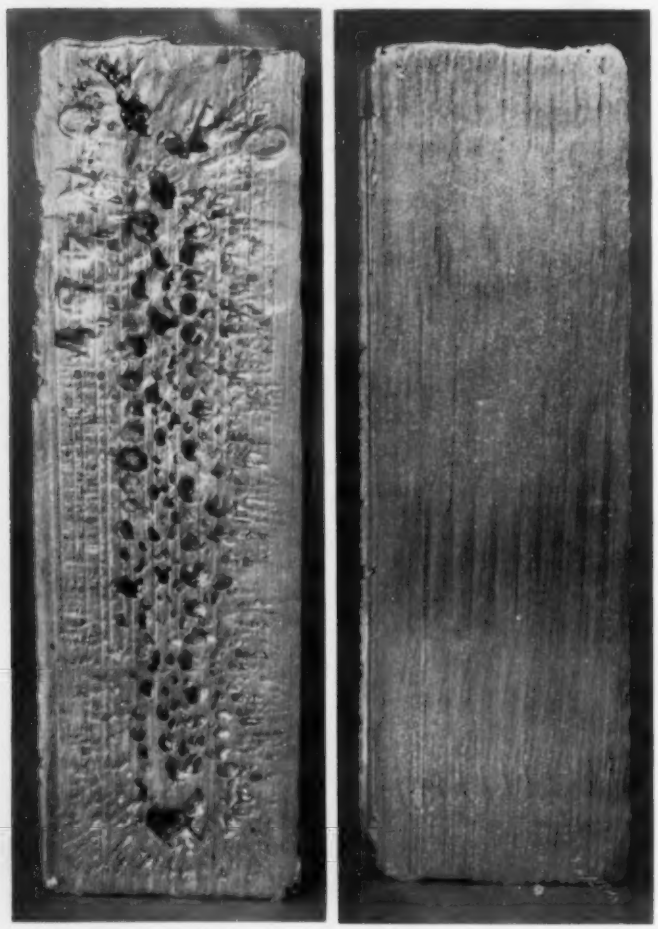
High-purity nickel with 0.03 and 0.1% aluminum.

High-purity nickel with 0.2, 2.0 and 4.0% tungsten.

Close control over the melting cycle was maintained; the uniformity of processing conditions after the charge was completely melted may be judged from the fact that the complete cycle (helium purge, vacuum, hydrogen reduction, second helium purge, vacuum, additions and pouring under helium) varied only from 72 min. to 84 min. for all the ingots. Addition of desired elements made in helium 3 to 8 min. before pouring minimized possible reaction between the additive and the crucible. The tungsten additions were given 7 to 8 min. to insure complete solution.

Analytical results show that no one impurity is present in amounts exceeding 0.005% in any of the processed strip. No significant difference was observed between samples taken from the top and bottom of the ingots. The carbon content ranges from less than 0.001 to 0.002%; oxygen from less than 0.0001 to 0.0018%, and hydrogen and nitrogen are both below 0.0003%. The low carbon and oxygen show that the melting and processing has effectively removed these elements from the original carbonyl nickel powder. (It contained approximately 0.2% oxygen and 0.07% carbon.)

Fig. 3 (Left)—Gassy Ingots Resulting From Melting Pressed Carbonyl Nickel Slugs Under Controlled Atmospheres. Right is a cross section of sound, 26-lb. ingots made from slugs sintered and decarburized in wet hydrogen. Full size.



It is also of interest to record the marked effectiveness of magnesium and aluminum as deoxidizers. As little as 0.003% Mg begins to have an effect, and 0.03% practically removes all the oxygen. A similar effect is noted for the aluminum additions. Oxygen reported (vacuum fusion analysis) represents total oxygen in the form of gas or oxides.

Some idea of the relative purity attained by this process can be had from Table I, containing the analyses reported for other types of high-purity nickel used for studying the properties of the metal. The data by Raytheon Co. in the next to last line (reference No. 7) for strip processed from vacuum-melted special electrolytic nickel indicate that its purity approaches that of the nickel made in Bell Telephone Laboratories (last line in Table I) except for the higher carbon, iron, and oxygen. However, the data for vacuum melted single additive alloys containing Mg, Al, or W show higher impurities, some of the materials containing 0.03 to 0.1% Zr, others 0.005 to 0.020% Fe, 0.005 to 0.0083% Si, 0.005 to 0.01% Ca, and carbon as high as 0.0068%.

Type Material and Reference§	Element, % by Weight								Resistance*	Coefficient†
	Fe	Co	Si	Cu	Mg	Al	C	Others		
Materials Prepared From Sintered Powder										
Carbonyl nickel (1)	0.045	<0.001	0.001	<0.005	x	x	0.0045	x	x	x
Carbonyl nickel (2)	<0.04	x	<0.01	<0.01	<0.005	<0.005	<0.02	<0.01 Mn <0.005 S	7.170	0.684
Materials Prepared Directly From Electrolytic Strip										
Electrolytic nickel (3) (Inco)	0.0005	0.0003	—	0.0008	—	—	0.0025	x	6.844	0.692
Nickel sponge (4) (Johnson & Mathey)	0.0008	0.001	0.0008	<0.0004	0.0003	0.001	x	<0.0005 Mn	x	x
Materials Processed From Ingots Prepared by Pyrometallurgy										
Special electrolytic nickel (5)	0.03	0.016	0.006	0.006	—	x	0.005	0.004 S 0.001 O	7.235	0.667
Vacuum melted electrolytic nickel (6)	0.034	0.48	0.003	0.006	x	0.002	0.004	x	x	x
Vacuum melted, special electrolytic nickel (7)	0.006	<0.001	0.0035	<0.001	<0.002	<0.001	0.004	<0.001 S 0.0035 O 0.00006 N	x	x
Carbonyl nickel (8) melted under controlled atmosphere	<0.005	—	<0.005	<0.001	<0.005	—	0.001	<0.001 S 0.0015 O 0.0001 H 0.0001 N	6.984‡	0.690‡

— Not detected.
x Not reported.
* Resistance in ohm-cm. $\times 10^{-6}$ at 20° C.
† Temperature coefficient of resistance $\times 10^{-2}$ between zero and 100° C.
‡ Annealed for 30 min. at 600° C. in hydrogen.

§References:

1. "Recovery of Cold Worked Nickel on Annealing", by Erich Fetz; *Transactions*, American Society for Metals, Vol. 26, 1938, p. 961.
2. "Wiggin Nickel Alloys by Powder Metallurgy", by H. Wiggin, Birmingham, England. (Booklet.)
3. "The Properties of Pure Nickel", by E. M. Wise and R. H. Schaefer; *Metals & Alloys*, Vol 16, Sept. 1942, p. 424.
4. "The Kinetics of Oxidation of High-Purity Nickel", by E. A. Gulbransen and K. F. Andrew; *Journal* of the Electrochemical Society, Vol. 101, March 1954, p. 128.
5. "The Properties of Pure Nickel", by Louis Jordan and W. H. Swanger; *Journal of Research*, U. S. Bureau of Standards, Vol. 5, 1930, p. 1291.
6. "Thermionic Emission From Oxide Coated Cathodes as a Function of Core Material Impurities", by H. Bender; *LeVide*, May-June 1956, p. 112.
7. Final Report by Raytheon Co. to Bureau of Ships; Contract No. 63,058; Dec. 1954.
8. This paper.

A realistic appraisal can be made by comparing the resistivities and temperature coefficients of resistivity in the last two columns of Table I. The very low resistivity and high coefficient constitute good evidence that this new nickel prepared at Bell Telephone Laboratories possesses a purity heretofore unobtainable in fair-sized ingots prepared by pyrometallurgical means. The resistivity values closely approach those reported for special high-purity electrolytic nickel by Messrs. Wise and Schaefer of International Nickel Co. (reference No. 3).

In summary, it may be said that a pyrometallurgical method has been developed for preparing large quantities of high-purity nickel in which no single element exceeds 50 ppm. Additions of desired elements can be made without significantly altering this over-all purity. The strong deoxidizing effect of small quantities of magnesium and aluminum has also been demonstrated. The same method has recently been successfully extended to the preparation of high-purity iron and nickel alloys; preliminary spectrochemical analyses indicate a purity comparable to the alloys described in this paper.

In addition to providing adequate material for the important fundamental study of emission characteristics of oxide coated cathodes, this high-purity nickel and its alloys should be extremely useful for evaluating other properties. The effect of small quantities of single additives on the physical, electrical, chemical and magnetic properties of nickel can now be more thoroughly investigated. The effect of purity on the energy released by recovery and recrystallization during the annealing of cold deformed nickel may add substantially to the data used by other investigators to estimate quantitatively the density of dislocations, vacancies and interstitials. The influence of impurities on the rate of oxidation of nickel at elevated temperatures represents another promising field of current interest. Some of these studies are now under way and others are contemplated.



Correspondence . . .

Phase Diagrams for Oxidation of Metals

AUSTIN, TEX.

Three recent publications – the excellent review of Kubaschewski and Hopkins' "Oxidation of Metals and Alloys" in the April issue of *Metal Progress,* the digest of Gulbransen and Andrew's recently published work on oxidation of nickel-chromium alloys in the same issue, p. 180, and K. Sachs' paper on the scaling of nickel steels (*Journal* of the Iron and Steel Institute, Vol. 185, March 1957, p. 348-357) – prompt a suggestion for representing the oxidation of binary alloys by means of triangular phase diagrams.

Sachs constructed an isothermal section (Fig. 1) with rectangular coordinates of composition (nickel-iron) and of oxygen partial pressure at 1200° C. (2200° F.). This suffers from two disadvantages – unfamiliarity to the metallurgist, and lack of ability to define the oxygen content of the phases.

Such a diagram can be converted into the more standard form of an isothermal section of the ternary system iron-nickel-oxygen, with oxygen partial pressures shown as isobaric contours (Fig. 2). In making the conversion it was necessary to make one or two guesses – one because Fig. 1 does not show the oxygen content of the phases but only the nickel-iron ratios. Another concerns the continuity of the Fe_2O_3-NiO fields to give spinel compounds, since this area was beyond the range of Sachs's work. Figure 2 includes four one-phase fields:

1. Gamma solid solution between iron and nickel, in which a little oxygen is soluble, corresponding to limiting oxygen partial pressures of $10^{-11.8}$ atm. (Fe end) and $10^{-6.8}$ (Ni end).

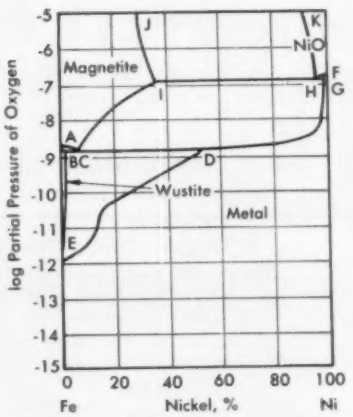


Fig. 1 – Isothermal Section With Rectangular Coordinates of Composition and of Oxygen Partial Pressure at 1200° C. (Sachs)

2. Wüstite, or FeO, which apparently dissolves only a little nickel, though variable in oxygen content, over a range with oxygen partial pressures from $10^{-11.8}$ to $10^{-8.7}$.

3. Magnetite, or Fe_3O_4, which has a large capacity for dissolving nickel (up to about 35%), little variation in oxygen content when nickel-free, but apparently a fairly wide range of oxygen content at intermediate nickel levels. The partial pressure of oxygen at the iron-rich limit is $10^{-8.7}$ and at the nickel-rich limit is $10^{-6.9}$.

4. The spinel field, S, crossing from hematite, or Fe_2O_3 (H) to NiO (N) and existing only at oxygen partial pressure above $10^{-6.9}$.

Between Wüstite, magnetite and gamma is a three-phase field, lettered W+M+γ, existing only at a single oxygen partial pressure– $10^{-8.8}$, and extending to a point on the γ boundary at 54% Ni. Between this three-phase field and the Fe corner is the two-phase field Wüstite+γ. Isobaric tie-lines, which fan out from the small Wüstite field to the long boundary of the gamma field, descend in partial pressure as they approach the iron corner, the lowest value being $10^{-11.8}$. Any low-nickel alloy brought into an atmosphere at a certain oxygen partial pressure, such as 10^{-10} atm., will

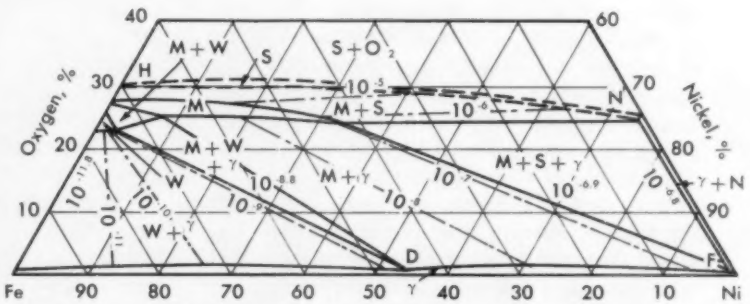


Fig. 2 – Isothermal Section of the Ternary System Iron-Nickel-Oxygen, With Oxygen Partial Pressures Shown as Isobaric Contours

STOP Aluminum Corrosion
INSURE Paint Adhesion

with TURCOAT 4178

THE QUICK-FIXING ALUMINUM SURFACE CONVERSION COATING

Proved by continuous 800 hour salt spray test!



HERE'S UN-RETOUCHED PROOF! Lower portion of aluminum coupon was coated with Turcoat 4178. Upper portion was not coated. Entire coupon was then subjected to 800 hour salt spray test. Note that uncoated portion has been virtually destroyed while Turcoated portion shows only superficial blemishes.

only PAINT-GRIPPING, CORROSION-RESISTING TURCOAT 4178 *offers you all these plus values!*

QUICK FIXING—Turcoat 4178 coatings become non-smearing immediately upon withdrawal from processing. Parts can be handled freely *while still wet* without danger of smearing or streaking coating.

MEETS MIL-C-5541—Used by aluminum fabricators the nation over for government and non-government jobs involving aviation, building parts, household appliances, luggage, ornamental aluminum, aluminum foil, irrigation pipe, automotive and truck parts and bodies, etc.

EASY TO USE—Applied by spray, dip or hand methods. Requires no heating... no electric current. Easily controlled by mere pH adjustment.

UNIFORM—No light tell-tale untreated sections around welds, corners or holes.

ECONOMICAL—Used at low concentrations. Extremely long-lived. Will accept tremendous contamination without loss in efficiency.

COLORS—Available in gold iridescent or natural aluminum.

FREE **SHOWING—TRAINING MOVIE!**

"ALUMINUM FINISHING"

New full-color film visually demonstrates *every* aspect of aluminum finishing from laboratory theory to authentic production-line techniques filmed on-the-spot during mass production. If your plant or technical group is interested, write today for full details without cost or obligation.

WRITE FOR TECHNICAL DATA... FREE! 4 pages full of technical information on Turcoat 4178, the quick-fixing aluminum conversion coating. Write for your *free* copy, without obligation... *today!*

TURCO PRODUCTS, INC.

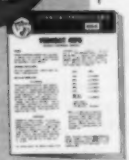
Chemical Processing Compounds

6135 SO. CENTRAL AVE., LOS ANGELES 1, CALIF.

Factories: Newark, Chicago, Houston, Los Angeles, London, Rotterdam, Sydney, Mexico City, Naha (Okinawa)

Manufactured in Canada by B. W. Deane & Co., Montreal

Offices in all Principal Cities



MAIL COUPON TODAY!

TURCO PRODUCTS, INC.

6135 So. Central Ave., Los Angeles 1, Calif.

- ☐ Please send free technical information on Turcoat 4178
- ☐ Please send details on the training film "Aluminum Finishing."
- ☐ Please have salesman call

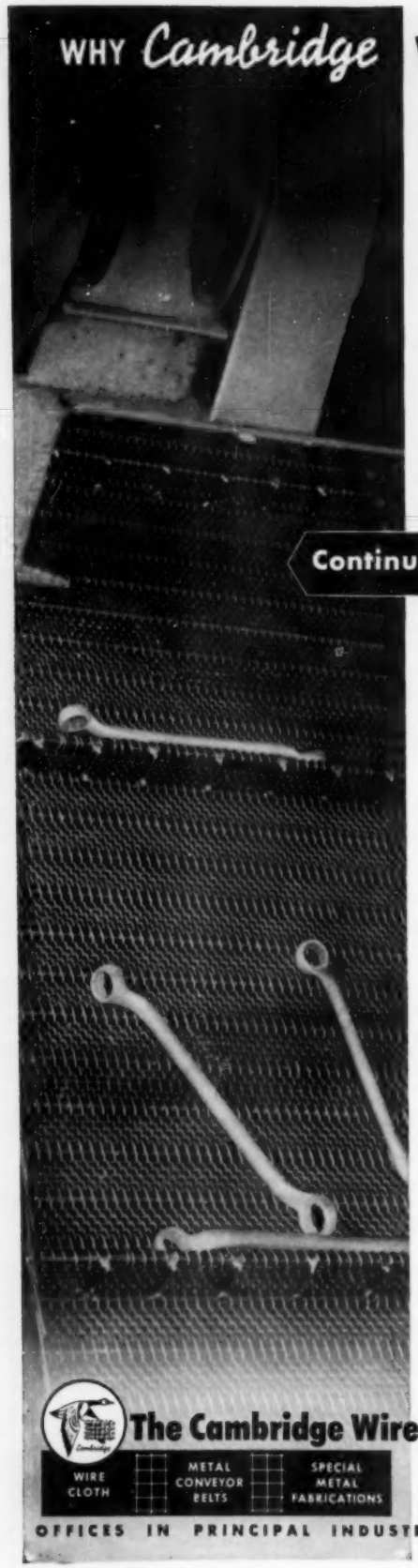
NAME _____

TITLE _____

FIRM _____

ADDRESS _____

MF



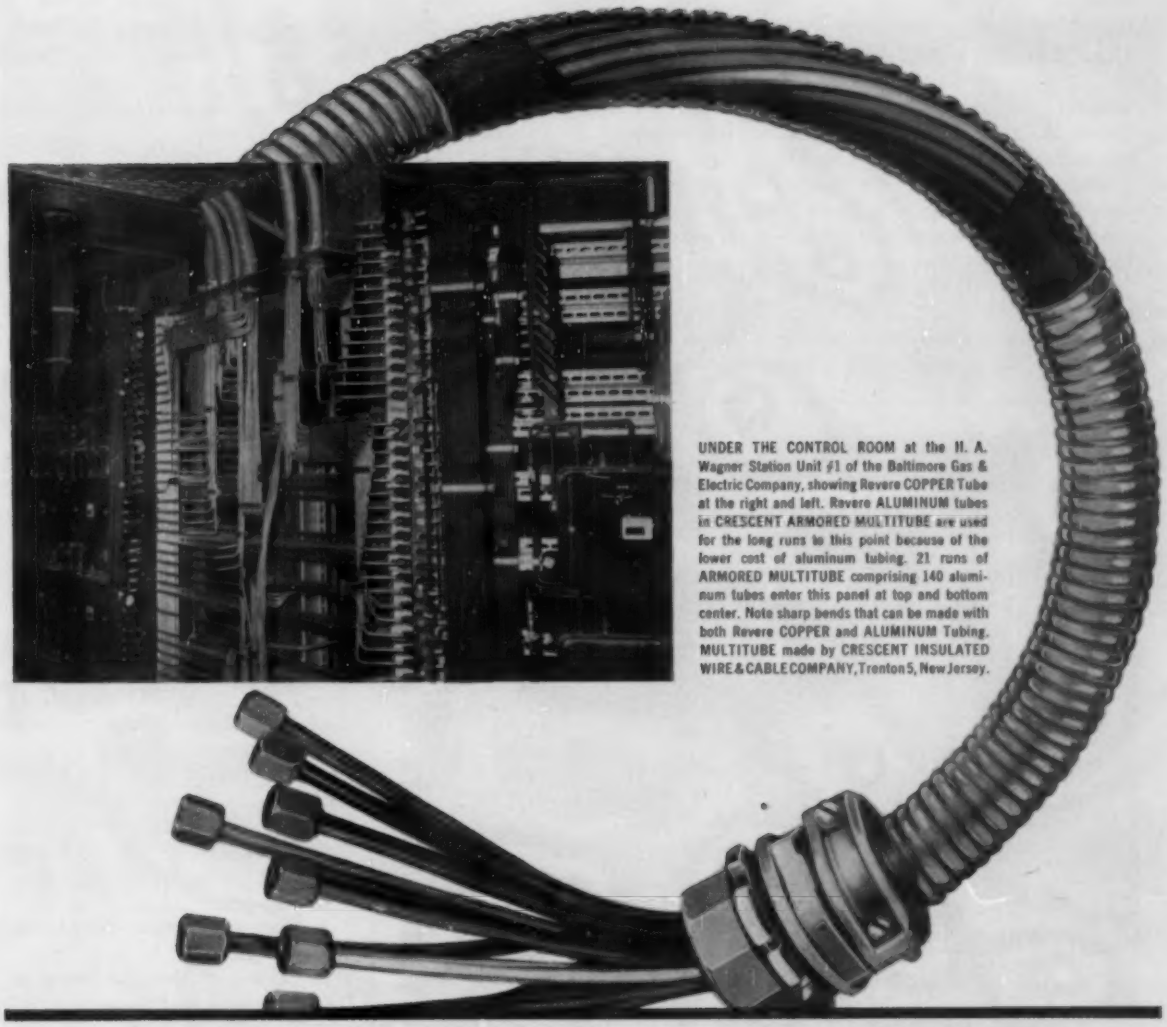
Oxidation Diagram . . .

tend to an equilibrium where Wüstite is in equilibrium with an enriched alloy.

The approximate composition and proportions of the phase may be determined by proceeding as in the following example covering a 3% Ni-Fe alloy at 10^{-10} atm.: Join the 3% Ni-Fe alloy composition by a straight line to the oxygen corner and find the point where the line intersects the 10^{-10} tie-line. Read off the proportions of the two phases connected by the tie-line according to the lever rule. The metal phase entangled in the scale should contain 26% nickel. At the same oxygen partial pressure, any other nickel content would lead to the same composition but the proportions of the phases would be altered. At any higher oxygen partial pressure, the nickel content of the metal entangled in the scale would be higher; for example, at 10^{-9} atm. it will lie at the extremity of the tie-lines, moving to the right with increased partial pressure until point D is reached. It is clear that no composition of metal entangled in the scale can exceed the nickel content at D, so long as Wüstite is present, but that the magnetite layer may contain metal enriched in nickel up to the content at F, namely, about 99% Ni; the equilibrium will then involve higher partial pressures — from $10^{-8.8}$ up to $10^{-6.9}$.

All alloys with more than about 9% nickel are capable of entering the magnetite+gamma field and giving magnetite scale layers in which the entangled metal is very much enriched in nickel. Beyond the M+γ field comes the M+γ+S three-phase field at $10^{-6.9}$ atm., and the N+γ and S+M two-phase fields at higher oxygen partial pressures.

The diagram can be used to work out what will happen when a mixture of iron and nickel oxides is reduced; it shows a wide range of conditions in which the nickel can be reduced, while the iron remains as oxide (with some nickel contamination). Another example is the sintering of powdered Permalloy (78% Ni, 22% Fe). The diagram indicates that, if this alloy is heated to 1200° C. (2200° F.) in a gas with an oxygen partial pressure of more than about $10^{-8.5}$ atm., pref-



UNDER THE CONTROL ROOM at the H. A. Wagner Station Unit #1 of the Baltimore Gas & Electric Company, showing Revere COPPER Tube at the right and left. Revere ALUMINUM tubes in CRESCENT ARMORED MULTITUBE are used for the long runs to this point because of the lower cost of aluminum tubing. 21 runs of ARMORED MULTITUBE comprising 140 aluminum tubes enter this panel at top and bottom center. Note sharp bends that can be made with both Revere COPPER and ALUMINUM Tubing. MULTITUBE made by CRESCENT INSULATED WIRE & CABLE COMPANY, Trenton 5, New Jersey.

CRESCENT relies on REVERE

for dependable performance of its instrumentation and control tubing

REPORTS, "NOT ONE FAILURE."

The dependable performance of Revere Copper Tube in Crescent Armored Multitube*, ever since its inception, has led the CRESCENT INSULATED WIRE & CABLE COMPANY to fill its aluminum tube needs with Revere also.

In fact, Crescent, since it first started using Revere Copper Tube in 1953, reports not a single failure. And that's mighty important in instrumentation and control tubing service where utilities, chemical processing, petroleum, paper and similar industries can't afford the luxury of process failures.

Crescent Multitube, using either Revere Copper or Aluminum Tube, or both in combination, offers a completely protected installation for permanence, lower original installation cost, lower maintenance and a saving of time, space and money.

Crescent Armored Multitube consists of a group of Revere Copper or Aluminum Tubes, twisted together in cable form, protected by a flexible interlocked galvanized steel armor. Constructions are available employing plastic sheaths in combination with the armor for corrosive locations. Section of cabled tube pictured shows how Copper or Aluminum Tubes are encased inside the Armored Multitube. As many as 37 tubes of ¼" OD can be cabled in lengths up to 1,000 ft.

For details on Multitube write Crescent and for uniform quality copper and aluminum tube, speedily delivered, see the nearest Revere Sales Office.

*Reg. Trademark

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

Mills: Rome, N. Y.; Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N. Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities, Distributors Everywhere.

Oxidation Diagram . . .

erential oxidation of iron will take place, with enrichment of the alloy in nickel, and the extent of enrichment increases with the oxygen partial pressure. Again, in the treatment of scrap or turnings of an alloy with 54% Ni or more, the diagram shows that almost all of the iron may be oxidized out at, say, 10^{-8} atm. with little nickel oxidation, leaving an alloy much enriched in nickel. If a higher partial pressure of oxygen were used – say 10^{-7} atm. – better nickel would be produced but recovery would be decreased since the magnetite then formed would have a high nickel content (approaching 35%).

Diagrams such as this could be constructed for the iron-nickel-oxygen systems at other temperatures or for isothermal sections of other metal systems with oxygen, and related diagrams may be drawn for three metals one of which is volatile. Such diagrams would give more complete information than other methods and would be readily understood by the metallurgist familiar with the common ternary diagrams.

E. H. Bucknall
Visiting Professor of
Mechanical Engineering
University of Texas



Hardenability Test for Deep Hardening Steels

Chicago

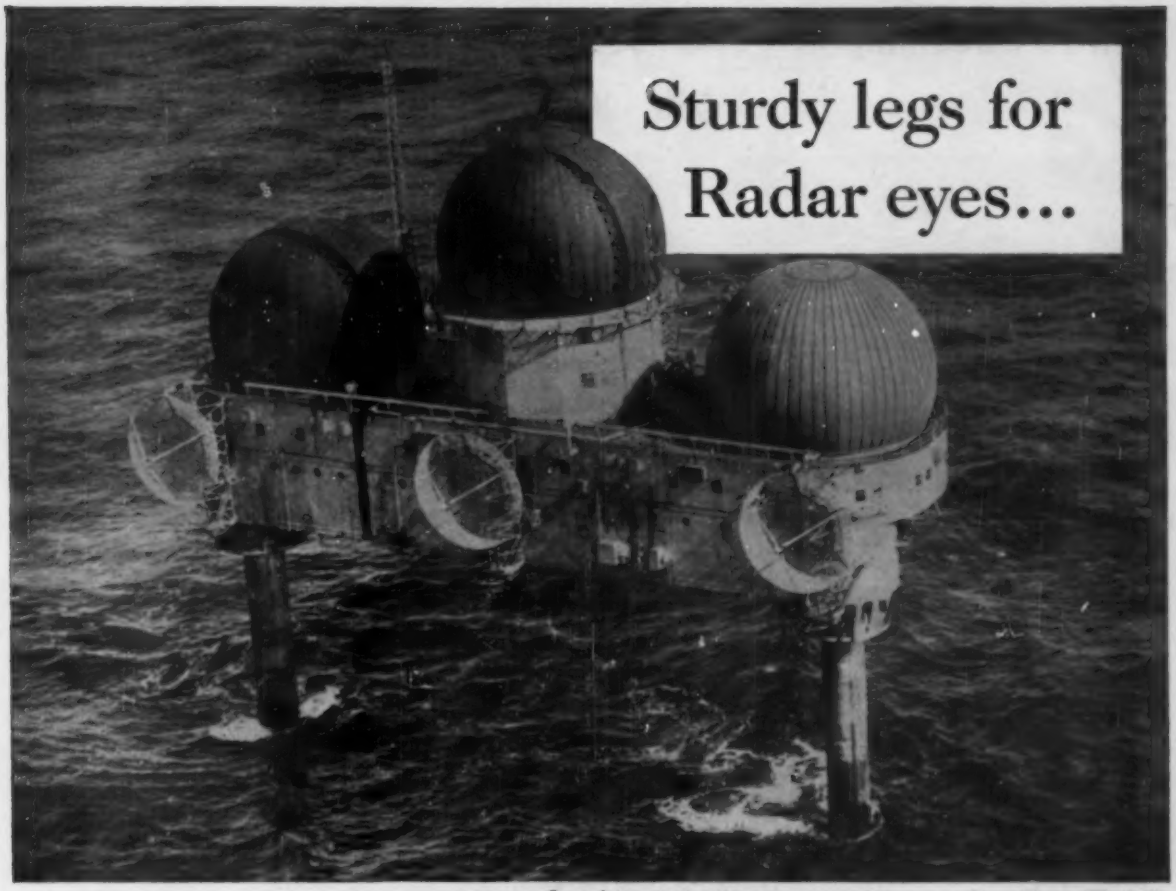
An article under the above title by Messrs. Carman, Armiento and Markus of Frankford Arsenal appeared in the May issue of *Metal Progress*, which describes a modification of a test developed for A. Finkl & Sons Co. by the undersigned while he was with Armour Research Foundation. This is noted at the outset of the article. It is my remembrance that Mr. Carman visited Armour about six years ago and we tested two bars of NE 98 V 65 for him in our original equipment.

I must commend the authors' efforts to simplify my test because it is complex. The authors cite three disadvantages:

1. A complex furnace with internal cooling coils.
2. Control of electrical power to the top furnace zone during the test.
3. Necessity of determining cooling curves on each test.

In an effort to simplify matters the Frankford Arsenal scheme is to drop the quenched end of the specimen 3 in. below the furnace and the equalizer tube a shorter distance, thus providing a radiation shield and eliminating furnace effects – except for tube conduction – at distances up to 3 in. The result is that the cooling rates in the pearlitic and bainitic range (at, say, 4 in. from the quenched end) are not similar to commercial quenching. More pronounced furnace effects are to be expected at greater distances from the end of the test specimen. To avoid these I have installed cooling coils in my test furnace.

The authors prefer to program all three furnace zones identically instead of shutting off the bottom two zones and programming the top zone as I did. Their preference should limit the useful length of the



One of America's offshore radar warning towers—Texas Tower III—built by Walsh Holyoke Division, Continental Copper and Steel Industries, Inc.

...with each seam checked on Kodak Industrial X-ray Film, Type AA

2700 tons of island rest on these 272-foot welded caissons. With giant seas and howling gales to stand against, every seam must be sound. Radiography provided the evidence of each weld's quality.

Each weld was radiographed using a 10 curie pill of cobalt 60. And because Kodak Industrial X-ray Film, Type AA, provides greatly increased film speed, exposure times could be moderate.

While giving speeds up to twice that of the former Kodak Type A Film, this new film retains the fine sensitivity characteristics which made Type A the most widely used x-ray film in industry.

Your x-ray dealer and the Kodak Technical Representative will gladly tell you how this new film can improve your radiographic operation and help you get more out of your present x-ray or gamma-ray equipment. It can pay you to get in touch with them.

Read what the new Kodak Industrial X-ray Film, Type AA, does for you:

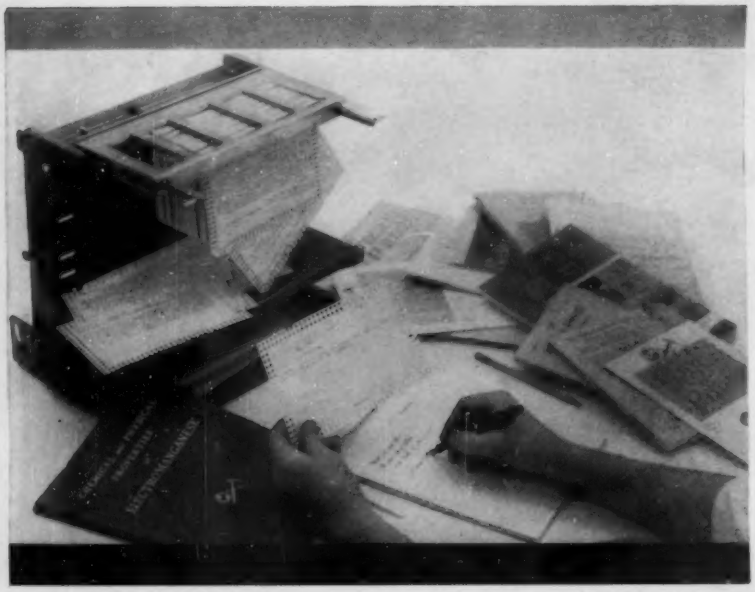
- Reduces exposure time—speeds up routine examinations.
- Provides increased radiographic sensitivity through higher densities with established exposure and processing technics.
- Gives greater subject contrast, more detail and easier readability when established exposure times are used with reduced kilovoltage.
- Shortens processing cycle with existing exposure technics.
- Reduces the possibility of pressure desensitization under the usual shop conditions of use.

EASTMAN KODAK COMPANY
***X-ray Division*, Rochester 4, N. Y.**

Kodak
TRADE MARK

For welding, Kodak Industrial X-ray Film, Types AA, M, and K, are available in the new 70mm by 550 ft. package.

new . . . booming . . . stainless steels call for alloy help



and ELECTROMANGANESE® has it

New, high-manganese stainless steels are catching on fast. Their lower costs and better mechanical properties are just one reason. Producers and fabricators of the old high-nickel 300 Series alloys, now able to minimize the effects of nickel shortages, are switching to the new 200 Series. Others who have long looked with interest at stainless, but were discouraged by possible shortages, are adding to the growth.

If you are a steel producer, when you pursue the new stainless steels you'll need more manganese. You'll call for the purest manganese made . . . electrolytic manganese . . . because it's the cheapest way to get the necessary manganese content without harmful impurities.

The Electromanganese Division of the Foote Mineral Company is ready to help you get started. Since its development of 99.98% pure manganese on a commercial basis some 17 years ago, when people said it couldn't be done, it has built its reputation upon service. A letter from you will bring the technical knowledge resulting from this experience to your desk through a Foote engineer. Or, if you'd prefer more information first, you'll receive it promptly by writing our Technical Literature Department, Foote Mineral Company, 424 Eighteen West Chelten Building, Philadelphia 44, Pa.

Foote MINERAL COMPANY

SALES OFFICE: *Electromanganese Division, Knoxville, Tennessee*
RESEARCH LABORATORIES: *Berwyn, Pennsylvania*
PLANTS: *Cold River, N. H.; Exton, Pa.; Kings Mountain, N. C.; Knoxville, Tenn.; Sunbright, Va.*

ELECTROLYTIC MANGANESE METAL • WELDING GRADE FERRO ALLOYS • STEEL ADDITIVES • COMMERCIAL MINERALS AND OXIDES • ZIRCONIUM & TITANIUM (IODIDE PROCESS) • LITHIUM METAL CHEMICALS AND MINERALS • STRONTIUM CHEMICALS

Hardenability Test . . .

bar to less than 10 in., but actual cooling curves beyond 4 in. from the end are now shown in their Fig. 3.

An inherent problem in both tests is heat storage, and this requires a new correlation for each widely varying solution temperature. Between 6 and 10 in., the hardenability curves they show for NE 86 V 65 indicate this sensitivity of my test as modified by Carman and his associates.

My paper does not state, as the authors write "... that cooling curves must be determined on each test as it is run". My words were: "The continued use of thermocouples in every test bar provides an excellent method of detecting irregularities in the testing procedure."

Table II of the closure to my original paper in *Transactions* of the A.S.M., Vol. 43, 1951, p. 154, shows the reproducibility for a single solution temperature without analyzing each set of cooling curves. In 30 tests the average time to reach 900° F. was recorded as t and the standard deviation s was estimated for the various positions. The relative variability is $s \div t$, and for 1 in. from the quenched end was 0.18; at 4 in. it was 0.09; at 7 in. it was 0.07; and at 8½ in. it was 0.08. These values compare favorably with the 0.17 value for the 1-in. position on the Jominy test. Similar data for the revised test methods would be informative.

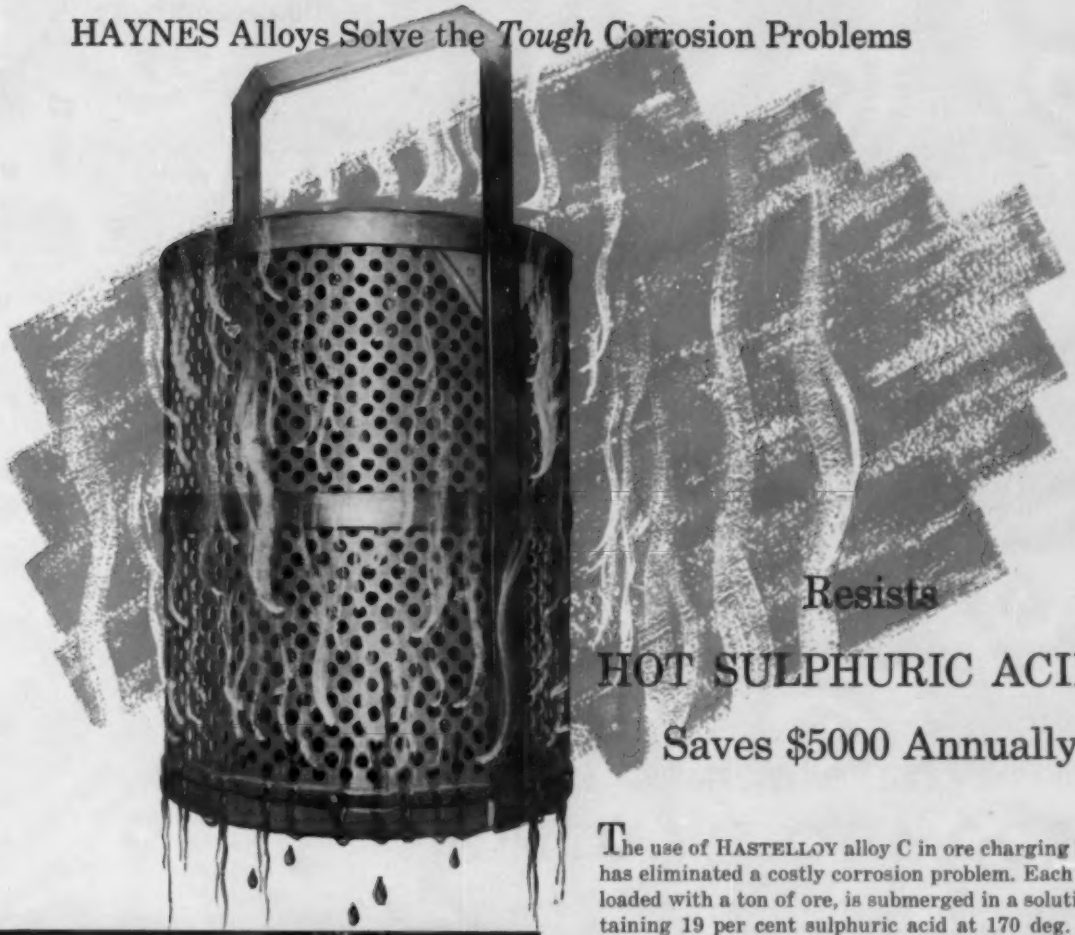
WILLIAM WILSON, JR.
Director of Research and Development
A. Finkl & Sons Co.

PHILADELPHIA

The authors wish to thank Mr. Wilson for his comments. The shape of the cooling curves is the result of designing the test to reproduce in the first 3 in. the water quenching effect of a 12-in. long Jominy specimen over the same length. This makes the quenching over this length amenable to simple mathematical analyses. Slower cooling was observed further along the specimen, but our materials could be tested within the first 3 in. and thus no efforts were made to utilize this effect. Undoubtedly, with added effort directed toward controlling the upper furnace zones, deeper hardening steels could be tested.

It was not the intent or purpose of

HAYNES Alloys Solve the *Tough* Corrosion Problems



Resists HOT SULPHURIC ACID... Saves $5000 Annually

The use of HASTELLOY alloy C in ore charging baskets has eliminated a costly corrosion problem. Each basket, loaded with a ton of ore, is submerged in a solution containing 19 per cent sulphuric acid at 170 deg. F. The acid salts formed during the process are oxidizing and reducing. Yet the corrosion rate on the HASTELLOY alloy parts is less than 0.004 in. per year! It is estimated that the alloy C parts will last for 20 years at an annual maintenance saving of $5000 per basket ... An overall saving of 100,000 dollars!

For complete information on the physical, mechanical and corrosion-resistant properties of HASTELLOY alloys, ask for our newly published 104-page book. Address Haynes Stellite Company, Division of Union Carbide Corporation, General Offices and Works, Kokomo, Indiana.





Corrosion resistance plus high strength makes HASTELLOY alloy C the ideal choice for use in ore charging baskets. They carry a ton of ore and are expected to last 20 years.

HAYNES ALLOYS

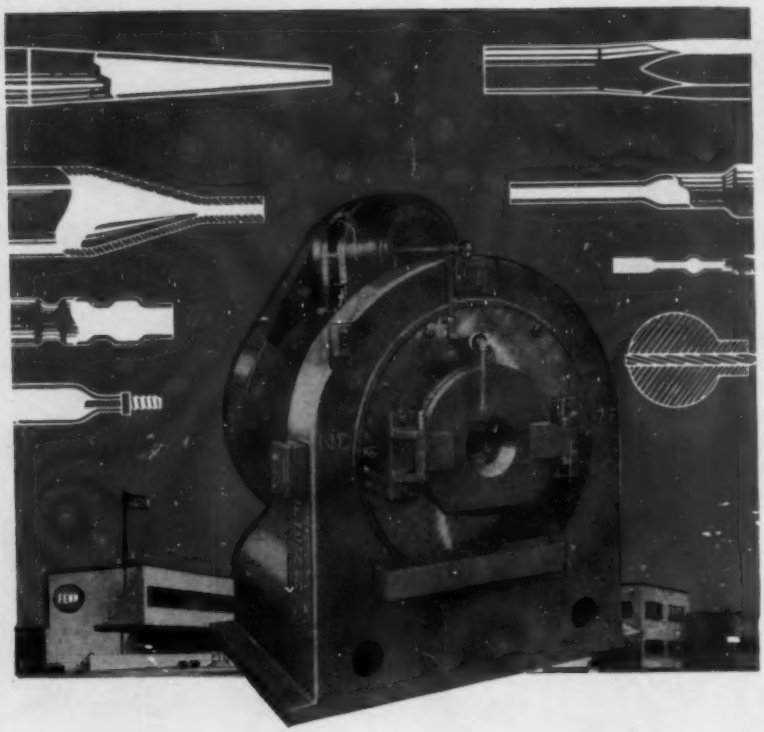
HAYNES STELLITE COMPANY

Division of Union Carbide Corporation

Kokomo, Indiana

UNION CARBIDE

"Haynes," Hastelloy" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.



What's behind the BOOM TO SWAGING?

Plenty . . . in these days of intense competition, higher costs of capital equipment, labor, and materials. Cost-conscious production men are finding it far better and cheaper to swage many parts they formerly machined. Fenn's development of the Rotary Swager has produced a dependable, low cost precision production machine for reducing, pointing, tapering, sizing, assembling, bonding and forming ID contours . . . with tolerances to within ± .001. Fenn Swagers are preferred for their compact design, extra heavy one-piece frame that assures rigidity and perfect alignment for long, dependable use at precision standards. A complete range of sizes is available with capacities in solid bar stock from 5/32 to 3⅜, and tubing to 6". Fenn also manufactures a full line of manual and automatic feeds and precision swaging dies. To be sure that you are not machining when you should be swaging, send for Fenn's fact-filled Swaging Catalog No. SM56.



FENN ROTARY *Swaging Machines*

THE FENN MANUFACTURING COMPANY • 507 FENN ROAD, NEWINGTON, CONN.

Hardenability Test . . .

the authors to misquote Mr. Wilson regarding the determination of cooling curves with each test. The three main disadvantages cited represent our honest opinion regarding Mr. Wilson's test.

The quenching data from the specimens used for Fig. 5 in the paper were analyzed by Mr. Wilson's method and the results are as follow: s ÷ t for 1 in. from the quenched end was 0.23, at 2½ in. it was 0.13 and at 4 in. it was 0.11. These results compare favorably with the Jominy test and the Wilson test.

CARL M. CARMAN
Metallurgist
Frankford Arsenal

Timely Review of Metal Literature

NEW YORK CITY

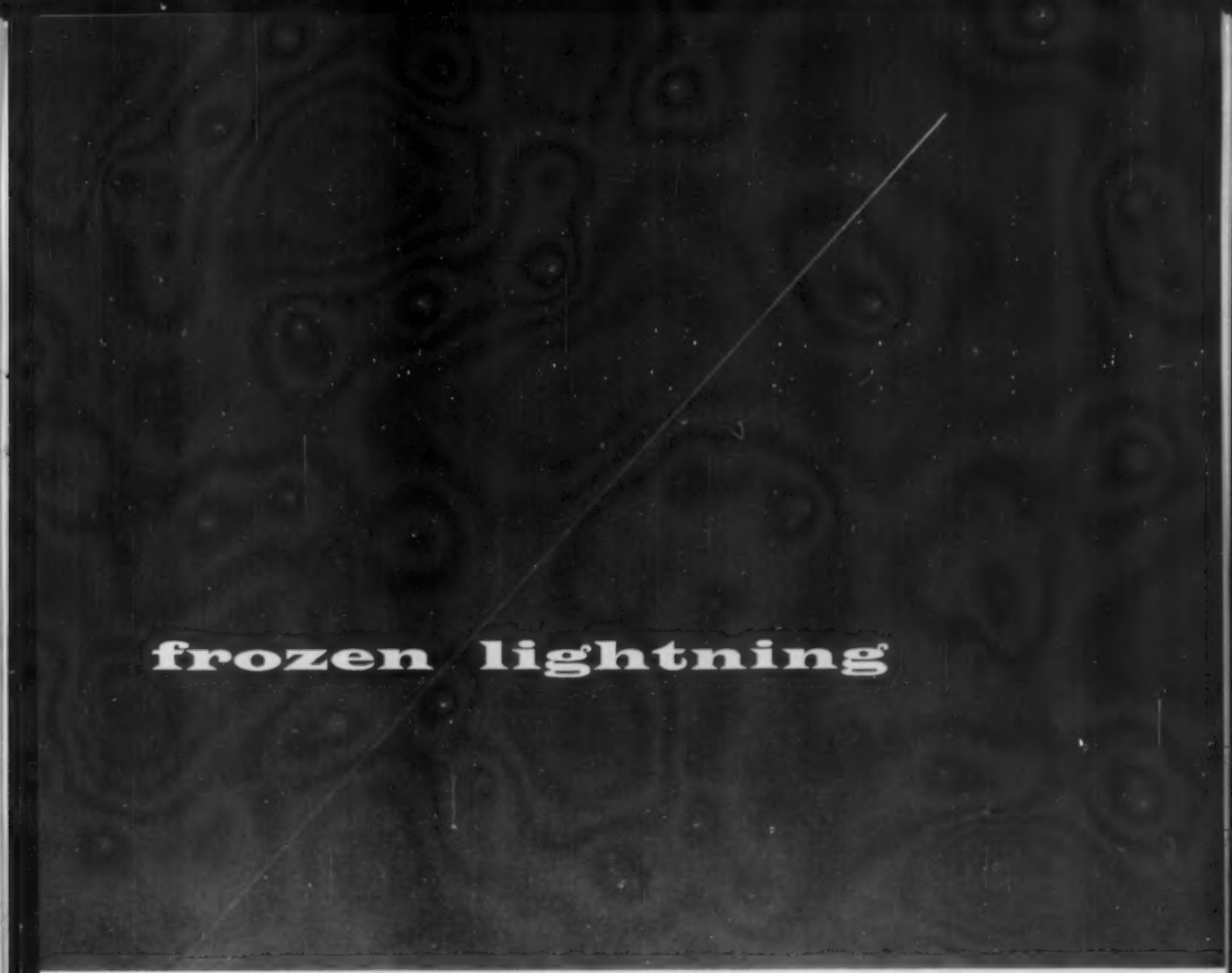
Until I recently re-evaluated the timeliness of the *A.S.M. Review of Current Metal Literature* I was continually frustrated and vexed by the time lag between the publication of the journals and the abstracts of their important articles by the various services which watch the engineering and scientific literature. Three months was the shortest interval (for relatively few items), six to nine months was usual, and a year commonplace.

Such time-lag forces diligent searchers of literature to go directly into the great number of scientific and industrial journals just as soon as they are delivered, for anything they may contain that may be significant for their companies' research and development staffs. This is needlessly expensive for subscriptions to journals and for wages of library personnel.

Happily I now note that *A.S.M. Review of Current Metal Literature* is as close as two months to the periodical sources of its classified annotations. This is much, much more satisfactory. In view of the fact that many monthlies actually get into the mails after mid-month, perhaps this is the minimum possible.

Much praise and appreciation to all responsible.

MYRON WEISS
Editorial Counsel



The Germans called the upper-atmosphere trails of their V-2 rockets "frozen lightning". When the Mach 4-5 aircraft now under development fly at 80-90,000 feet and higher, we'll be seeing frozen lightning in our own skies.

Not freezing but heating will be the *real* problem at these ultra high speeds. At 3000 mph, the skin and many structural components will be heated to over 1000°F, temperatures too high for alloys now used. Needed: materials strong up to 1200-1300°F for structural forgings and other stressed parts.

Engine builders, fastener manufacturers and forge shops are handling similar requirements right now, with Carpenter alloys. These alloys have gained an enviable reputation for uniform high quality, ability to meet tough specifications consistently, improved forgeability and exceptional cleanness. Forging tolerances can be tighter. Finishes are better. Rejects are far fewer.

Design properties and fabrication instructions for these alloys are summarized in our new booklet, "Carpenter Alloys for Elevated Temperature Service". For your copy drop us a line on your Company letterhead. The Carpenter Steel Company, 133 W. Bern Street, Reading, Pa.

Carpenter STEEL

Improved alloys for elevated temperature service

Personal Mention



Arthur L. LaMasters

ARTHUR L. LAMASTERS has joined Michigan Industries Co., Detroit, as vice-president, with functional responsibilities for sales for the company's five divisions: Michigan-Standard Alloys Casting Co., Misco Fabricators Co., WaiMet Alloys Co., M. S. Machine Products Co., and Western Foundry Co.

Mr. LaMasters received his metallurgical and electrical education through correspondence schools and study at Illinois Institute of Technology. His early engineering work was on the development of the first high-frequency induction method of heat treating railroad rails for Teleweld, Inc., in Chicago. In 1940, as chief engineer for Claud S. Gordon Co., Chicago, he turned to the field of high temperature and corrosion resistance, and this has been his major interest for the past 14 years. After four years, he joined Alloy Engineering & Casting Co., and remained with this company until he resigned as vice-president in October 1956.

Active in the American Society for Metals for the past 20 years, Mr. LaMasters served as chairman of the Peoria Chapter in 1956-57. In addition to other technical societies, he is a member of the Aircraft Owners and Pilots Assoc., and an avid aviation enthusiast, flying his own plane for both business and pleasure trips.

L. A. Kristoff recently opened a consulting office, Alti Metals, Inc., in Cleveland, and acts as consultant to the casting and fabricating segments of the aluminum industry.

John C. McDonald, assistant technical director of the Dow Chemical Co. magnesium department, received the annual Willard H. Dow Award for Research in Magnesium. Dr. McDonald was cited for his "outstanding contributions in the field of elevated-temperature magnesium alloys, particularly for inventing magnesium-thorium alloys". These latter alloys are being used increasingly for supersonic aircraft and guided missile structural materials. Dr. McDonald joined Dow in 1936 after receiving his doctorate from the University of Minnesota, and since 1951 has held his present position, in addition to heading the company's metallurgical laboratory.

Robert P. Marshall has been assigned to the new Trane Co. plant, to be erected in Clarksville, Tenn., as factory superintendent. The new plant will produce central-type residential air conditioners. Currently, Mr. Marshall is taking part in a planning program at the company's La Crosse, Wis., plant.

Edwin F. Mitchell has retired from Continental Foundry and Machine Co., a division of Blaw-Knox Co., Chicago, and now lives in Miami Beach, Fla.

Don P. Selby has assumed the post of assistant manager of sales for the U.S. Steel Corp. district office in Cincinnati, Ohio. Mr. Selby first worked for U.S. Steel part time during his college days at Carleton College, and after graduation in 1939, was named promotion engineer in the company's Pittsburgh sales office. He has served in various sales offices, more recently as assistant to the manager of sales in the Pittsburgh sales office and since 1956 as assistant manager in specialty products sales there.



Fred L. Plummer

The American Welding Society has named FRED L. PLUMMER national executive secretary and technical director, succeeding JOSEPH G. MAGRATH who resigned recently after 10 years as secretary.

After receiving a bachelor's degree from Ohio University and Case Institute of Technology, Mr. Plummer returned to Case to receive his master's degree, and then in 1923 joined the faculty of the school as an instructor in mathematics, and civil and structural engineering. In addition to his teaching duties, he acted as consulting engineer to a number of companies, and in 1937, he resigned his position as associate professor to serve as chief design engineer for the construction of the Main Ave. Bridge Project in Cleveland. Since 1940, Mr. Plummer has been director of engineering of the Hammond Iron Works in Warren, Pa., and general manager of Hammond Latina Americana Construction Co.

Mr. Plummer has served in various executive positions in the A.W.S., including two terms as national president in 1952-54; last May he was awarded the A.W.S. Samuel Wylie Miller Memorial Award for his outstanding contributions to the society. He has been active in A.S.M. and at present is heading the committee which is organizing the sessions on welding and joining at the Second World Metallurgical Congress this fall.

FAHRITE

HEAT AND CORROSION *Alloys*

CASTINGS FOR HIGH TEMPERATURE SERVICE





DESIGNED FOR SPECIFIC HEAT TREATING APPLICATIONS

Every heat treating operation has its own special casting requirements. Our engineers need only the facts about your particular heat treating operation to design and produce Fahrite castings with the correct characteristics to meet your problems.

Fahrite alloy castings are products of careful design, metallurgical and foundry control techniques—assuring sound, high tensile strength castings that resist thermal shock, stand up longer in service. There are grades of Fahrite to meet your exact operating conditions. A few of the many types of Fahrite castings made by Ohio Steel are:

Rails	Rollers
Chains	Radiant Tubes
Retorts	Fixtures
Solution Pots	Hearth Plates
Muffles	Display Baskets

Carburizing Boxes

OUR 50th YEAR 1907 1957

THE OHIO STEEL FOUNDRY CO.

SPRINGFIELD, OHIO

Plants at Springfield and Lima, Ohio

Is the Best Steel You Make the Best You CAN Make?

This is an economic rather than a rhetorical question. It has to do with providing those special characteristics which increase salability and profits!

Advances in Vacuum Metallurgy point quite definitely to the fact that High Vacuum techniques hold tremendous potentials for Steel (as well as other metals). And, these potentials run across a broad range of grades and alloys—not merely the costlier.

The Metallurgist can turn with confidence to KINNEY engineers for the High Vacuum Pumps and the "Know-How" to contribute sound guidance in selecting the equipment you need for laboratory, pilot plant and full scale production.

Kinney®

HIGH VACUUM PUMPS

The KINNEY Line of High Vacuum Pumps—the most extensive in the world—includes single-stage and two-stage mechanical Pumps covering the low micron range. And, in addition, there are KINNEY two-stage and four-stage Mechanical Booster Pumps. The two-stage Pumps produce ultimate pressures of 0.2 micron (McLeod) . . . the four-stage, .005 micron as measured on a trapped ionization gauge. These Pumps handle gas bursts that might completely demobilize ordinary Vacuum systems.

KINNEY High Vacuum Pumps and complete Furnaces, Degassers and Vacuum Ovens may well be the answer to your problems of product improvement. Tap this *Imaginative Engineering* for full information on what KINNEY High Vacuum can do for you.



KINNEY KMB two-stage Mechanical Booster Pumps with free air displacements from 230 to 5000 cfm develop ultimate pressures to .2 micron Hg (McLeod). The KINNEY KMB four-stage Pump with free air displacement of 30 cfm develops ultimate pressures to .005 micron Hg as measured on a trapped ionization gauge.

WRITE for detailed information on KINNEY High Vacuum Pumps and High Vacuum Equipment.



KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3584J WASHINGTON STREET • BOSTON 30 • MASS.

Kindly send me literature on KINNEY
☐ High Vacuum Pumps ☐ High Vacuum Equipment

Name_____

Company_____

Address_____

City_____ Zone____ State_____

Personals . . .

C. J. Ryan has been named to the newly created position of assistant to the vice-president, sales, for Crucible Steel Co. of America with headquarters in Detroit. Mr. Ryan's former position as manager of the company's Detroit sales branch will be filled by **M. J. Dempsey**, who had been assistant branch manager. Since joining Crucible in 1922 at the Sanderson-Halcomb works, Syracuse, N. Y., Mr. Ryan has served in various managerial posts, including office manager and assistant branch manager in Detroit. He was appointed manager of the branch in 1945. Mr. Dempsey has acted as assistant branch manager for the past year and before that was supervisor of tool steel sales for six years.

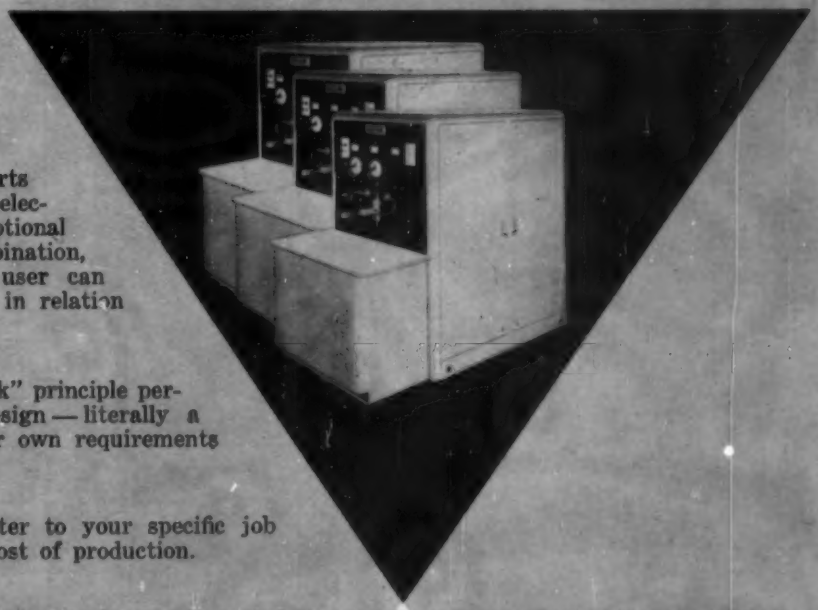
Norbert D. Greene has joined the staff of the Metals Research Laboratories of the Electro Metallurgical Co., a division of Union Carbide Corp., Niagara Falls, N.Y., as an assistant research metallurgist in the metals research group. Dr. Greene recently received his doctor's degree in metallurgical engineering from Ohio State University, where he worked as a research associate.

E. G. Smith, Jr., is now on active duty with the U.S. Air Force and is receiving pre-flight training at Lackland Air Force Base, San Antonio, Tex. Lieutenant Smith was formerly employed by Battelle Memorial Institute, Columbus, Ohio, and will return there upon being discharged after his three-year tour of duty.

James H. Marshall is now assistant chief metallurgist for the Dole Valve Co., Morton Grove, Ill.

Richard T. Haubrich, formerly employed by Greist Mfg. Co., New Haven, Conn., has joined Halloran Equipment Co., Hamden, Conn.

Leon S. Jablecki has been assigned to the Arnold Engineering Development Center of the Air Research and Development Command, Tullahoma, Tenn., as Air Force representative at the gas dynamic facility. Colonel Jablecki was deputy of aeronautics and propulsion at the Air Research and Development Command headquarters in Baltimore, Md., before his transfer.



1. Magnethermic starts with a good standard electronic heater. Ten optional features, in any combination, can be added. The user can evaluate each feature in relation to cost and need.

2. This "building block" principle permits flexibility of design — literally a custom design to your own requirements at minimum cost.

3. Matching the heater to your specific job reduces the per-unit cost of production.

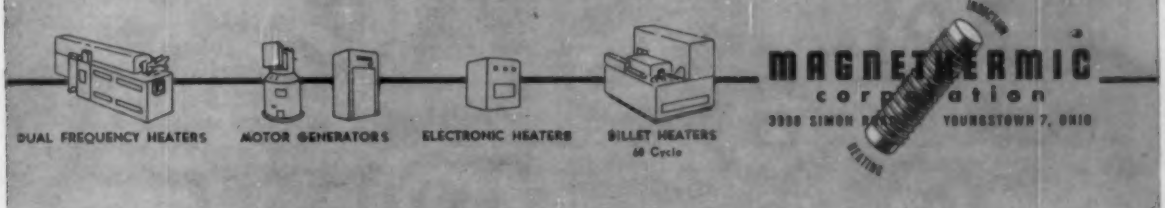
NEW IDEA IN ELECTRONIC INDUCTION HEATERS
Custom Design at Reasonable Cost....

4. Call upon Magnethermic's application and design engineers for your best combination of "building blocks".

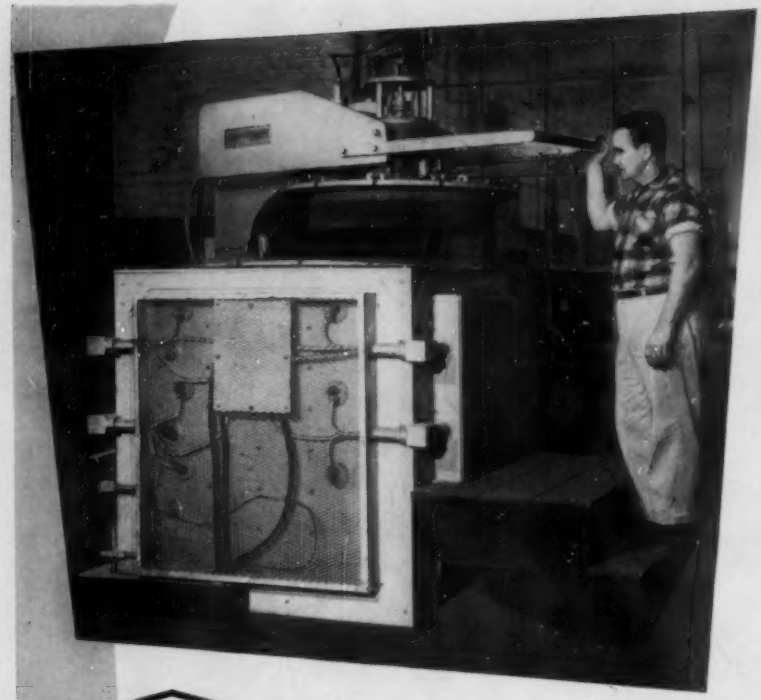
5. New Bulletin EH-57-6 contains full information on the standard electronic induction heater; the ten optional features; ratings; specifications on 15, 30 and 40 KW; a frequency selector chart; a surface hardening table; and other data.

6. Bulletin EH-57-6 is available upon request. Heaters available from stock. Address your inquiry to Magnethermic, Youngstown, O.





MAGNETHERMIC
corporation
YOUNGSTOWN 7, OHIO



LANDIS MACHINE COMPANY
USES THIS HEVI-DUTY

VERSA-DUTY PIT FURNACE

- For uniform temperature throughout the densest of loads and
- Ease of duplicating results from load to load.



"We have noted a marked improvement in the quality of our products because of greater uniformity in heat treatment . . . not only throughout each load . . . but from load to load." In addition, Mr. Leckie-Ewing, the chief metallurgist at Landis Machine Company, Waynesboro, Pennsylvania, says that because the tempering cycle is so easy to control, they can temper to within ±1 point Rockwell C.

If your products require nitriding, bright or steam tempering, annealing, bright or special bluing or non-atmosphere heat treating requiring temperatures to 1350°F, you can achieve outstanding results with Hevi-Duty's new Versa-Duty Pit Furnace.

High Speed Steel Chasers Tempered in Versa-Duty Pit Furnace.

Write for Bulletin 755 to find out how you can increase production, reduce rejects, save time, labor and floor space and eliminate many secondary operations.

HEVI-DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Heat Treating Furnaces... Electric Exclusively

Dry Type Transformers *Constant Current Regulators*

Personals . . .

John F. Salay was recently transferred from the Midland, Mich., office of Dow Chemical Co. to the magnesium sales department of the company's St. Louis sales office.

Robert D. Schelleng, a research metallurgist on the staff of the International Nickel Co. research laboratory at Bayonne, N.J., has been named supervisor of the ferrous castings section. After graduation from the University of Michigan, Mr. Schelleng subsequently held teaching and research fellowships at the university and received his master's degree there a year later. He then joined the staff of the Bayonne laboratory and since that time has conducted research on nickel alloy cast irons and ductile iron.

Wallace Sheely, who recently completed his studies towards a doctor's degree in metallurgical engineering at Rensselaer Polytechnic Institute, has become a member of the metals group of the Metals Research Laboratories of the Electro Metallurgical Co., a division of Union Carbide Corp., Niagara Falls, N.Y., in the capacity of assistant research metallurgist. Dr. Sheely's technical background includes experience as a research associate at Rensselaer and a post at the Allegheny Ludlum Steel Co.

James L. Cutler is now employed as a metallurgist with Hamilton Standard Div. of United Aircraft Corp. in Windsor Locks, Conn.

Richard E. Stoll has been promoted to the position of general supervisor of metals research at the South Works, U.S. Steel Corp., Chicago, Ill.

Robert M. Briney has accepted new responsibilities as president of the Haynes Stellite Co., a division of Union Carbide Corp., Kokomo, Ind. Mr. Briney began his career with the company in 1924 in the Niagara Falls, N.Y., plant of the Electro Metallurgical Co., another Union Carbide division. He held various key positions in the division until 1950 when he was made vice-president in charge of wrought alloy products for Haynes Stellite; he was transferred to the New York office in 1954.

Theo. B. Kaczmarek is now assistant superintendent for Cramet, Inc. in Chattanooga, Tenn.

The industrial heating division of Westinghouse Electric Corp. has opened a Pacific Coast branch in San Francisco under the management of **R. R. LaPelle**. **Donald P. Hoover** is industrial heating product engineer and **C. Kenneth Massey** is sales engineer, both with offices in Los Angeles.

F. J. Lockhart has been appointed a vice-president of Atlas Steels Ltd., Welland, Ont. Mr. Lockhart, who joined the Atlas sales staff in 1943, is manager of Canadian sales.

George E. Scargle has accepted an appointment as field sales engineer in the Philadelphia sales office of the Beryllium Corp., Reading, Pa. Mr. Scargle was affiliated with Whitehead Metal Products in Philadelphia before his appointment.

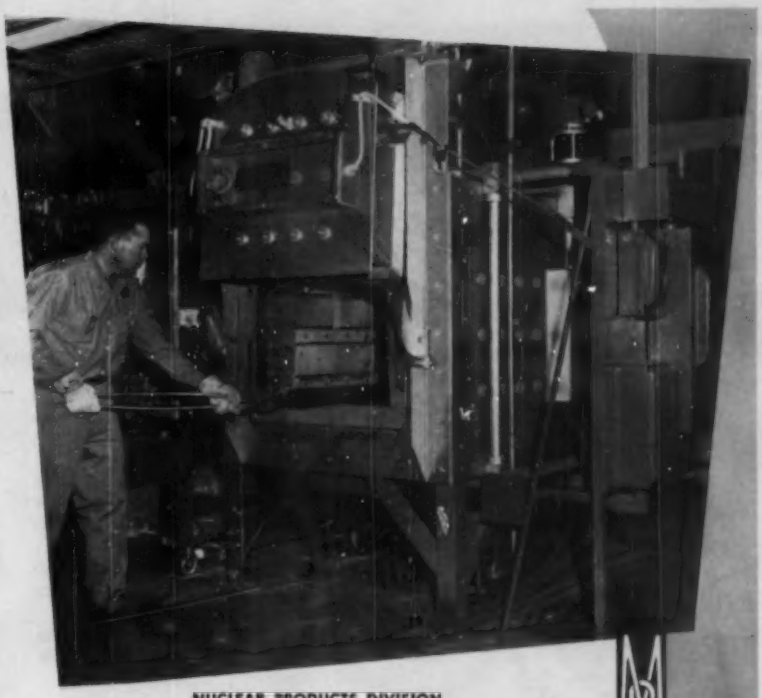
Del Steigerwald is now branch manager of Harshaw Scientific Div., Harshaw Chemical Co., Detroit.

Bernard C. Lindstrom has been appointed technical sales representative in New York state, excluding the New York City metropolitan area, for Heatbath Corp., Springfield, Mass. For the past four years, Mr. Lindstrom has been handling technical sales and service from the home office in Springfield.

J. Richard Mainier has joined the Cleveland sales engineering staff of the Barber-Colman Co., Rockford, Ill., as part of the company's program of expansion of sales and service facilities throughout the country. In Chicago, **Clemens Matula** has been added to the sales engineering staff of the company's branch there.

Lewis W. Davis, president of Metal Hydrides, Inc., Beverly, Mass., has been elected a trustee of Bates College in Lewiston, Me. Mr. Davis has been associated with Metal Hydrides since 1937, and was named president in 1953.

Albert P. Lospinoso recently received his bachelor of science degree from Lehigh University and is now employed by the U.S. Metals Refining Co., Carteret, N.J.



NUCLEAR PRODUCTS DIVISION

METALS & CONTROLS CORPORATION

USES THIS MULTI-RANGE

HEVI-DUTY BOX FURNACE

- To heat parts for rolling and bonding
- For critical aluminum brazing of nuclear fuel elements

"The versatility of our Hevi-Duty Electric Furnace enables us to perform many heat treating operations . . . from special heats for rolling and bonding of aluminum, uranium alloy or zirconium to the very critical operation of aluminum brazing of nuclear fuel elements."

Mr. Paul Moffat, manager of manufacturing engineering at the Nuclear Products Division of Metals & Controls Corporation, added that they are exceptionally pleased with the long heating element life under severe operating conditions and the wide variety of uses at temperatures to 1850°F.

Write for Bulletin 341 to see how you can put this versatile box furnace to work for you.



Nuclear fuel element brazed in Hevi-Duty Box Furnace.

HEVI-DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Heat Treating Furnaces... Electric Exclusively

Dry Type Transformers *Constant Current Regulators*

look at these advantages of

IRIDITE FINISHES

for

CORROSION-RESISTANCE, PAINT BASE on ALUMINUM and MAGNESIUM



EASE OF USE—Iridite is a simple chromate conversion treatment. Fast, easy, economical. You just dip, brush or spray it on the part at room temperature. No special equipment. No specially trained personnel.

OUTSTANDING PERFORMANCE—Forms a film that is an integral part of the metal itself. Can't flake, chip or peel. Takes paint firmly on initial application, and the bond lasts. Even protects areas scratched in use.

LOWEST COST—You have only minimum equipment cost, no special racks, high speed operation, lower overall handling costs.

CHOICE OF APPEARANCE—Clear coatings that retain metallic lustre to dark, maximum protection coatings. A variety of colors is available by dyeing.

IRIDITE #14 and #14-2 (Al-Coat) for ALUMINUM

Two specially formulated finishes that give you maximum latitude in aluminum treatment. Both provide excellent corrosion protection and paint base. Iridite #14-2 is an improved product that allows greater flexibility in operation and coating thickness and produces the optimum in corrosion protection.

Either coating provides corrosion resistance superior even to complicated electrolytic treatments in a fraction of the time. These coatings also offer many other valuable characteristics: they have low electrical resistance, they aid in arc-welding, provide a good base for bonding compounds, have no effect on the dimensional stability of close-tolerance parts. Final appearances ranging from clear through yellow iridescence to full brown can be obtained. By dyeing, you can produce red, green, blue, orange or yellow finishes.

IRIDITE #15 for MAGNESIUM

Produces a protective, paint base film with corrosion resistance at least equal to that obtained from long, high-temperature dichromate treatments in a fraction of the time and at room temperature. The appearance of the coating can be varied from light brown to dark brown and black.

APPROVED UNDER GOVERNMENT AND INDUSTRIAL SPECIFICATIONS

SEE FOR YOURSELF WHAT IRIDITE CAN DO . . . SEND SAMPLE PARTS FOR FREE PROCESSING. Look at the results, test the protection, evaluate the savings. Also write for handy Reference File of the most complete data published on chromate conversion coatings. Or, for immediate information, call your Allied Field Engineer. He's listed under "Plating Supplies" in your classified phone book.

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD



Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals; ARP Plating Chemicals.
West Coast Licensee—L. H. Butcher Co.

Personals . . .

J. J. Wycall has been promoted to branch manager of the St. Louis office of Crucible Steel Co. of America, Pittsburgh. Since joining Crucible at its Harrison, N. J. plant in 1933, Mr. Wycall has served in various posts, including sales service engineer of special products and more recently assistant branch manager.

M. L. Powers is now manager of engineering service of the Pittsburgh district for the Linde Air Products Co.

Edward R. Burrell, recently discharged from the U. S. Army, is an experimental metallurgist for the New Departure Div. of General Motors Corp., Bristol, Conn. While in the Army, Mr. Burrell was assigned to Frankford Arsenal, Philadelphia, as a metallurgist.

Warren Walker, Jr., was promoted to the position of assistant to the general warehouse manager for the Colorado Fuel and Iron Corp., at the Philadelphia office. He is responsible for all warehouses in the Wickwire Spencer Steel Div., of the corporation.

Eugene W. Emmerich has accepted a position with Allegheny Ludlum Steel Corp., Watervliet, N. Y., as a senior metallurgist, quality control, extrusion and cold draw division. He was previously associated with Rem-Cru Titanium, Inc., Midland, Pa., as a process and product development engineer.

Paul Biron was recently appointed plant metallurgist for Canada Iron Foundries Ltd., Toronto, Ont.

Raymond B. Roof, Jr. has become a staff member of the University of California Los Alamos Scientific Laboratory, Los Alamos, N. M. Dr. Roof is employed as a crystallographer in the CMF division of the laboratory, one of two divisions concerned with fundamental research in chemistry and metallurgy. Until this new appointment, he was a senior engineer in the atomic power division of Westinghouse Electric Corp., Pittsburgh.

John C. White is now manager of sales for the Seattle, Wash., district of Bethlehem Pacific Coast Steel Corp.



We can help

you "fit"

WIRE CLOTH

to your needs

These days, "fit" is an appropriate word when it comes to matching wire cloth to industrial needs—especially when you do business with the *Reynolds Wire Division* of National-Standard. Here's why . . .

First, there are of course the many different weaves, meshes, metals, finishes and coatings that provide for infinite combinations to meet any special requirement right on the nose.

Secondly, and highly important, Reynolds also "tailors" wire cloth to the precise *width* and *length* needed to minimize waste and to shave the last bit of excess cost out of production operations.

Finally, Reynolds helps you take the fullest advantage of these variables by providing truly unmatched engineering and analytical service . . . nation-wide. Can wire cloth do a *better* job for you? Can you cut costs? Could wire cloth be the answer for certain *new* requirements? Check with Reynolds . . . see what *Reynolds* service and quality control offers!

NATIONAL NS NATIONAL-STANDARD Company **STANDARD**

DIVISIONS: NATIONAL - STANDARD, Niles, Mich.; *fine wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *music spring, stainless and plated wires, high and low carbon specialties*

WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*

Here's How
CHAMPION
Upset Forgings
Give you a Better Product at Lower Cost

FOR SUCH PARTS AS:
Valve Stems
Pinion Gears
Cluster Gears
Boiler Braces
Pipe Couplings
Trunnion Shafts
Chain Pins

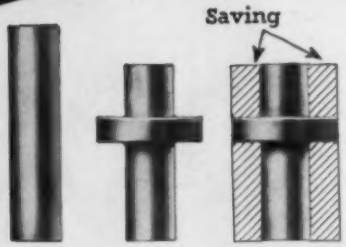


MAXIMUM STRENGTH

When a metal blank is upset, it will flow into the upsetting die and the grain structure will be changed into a pattern of smooth curves that conform to the die shape, resulting in a product with equal or greater strength than that of the blank used.

MAXIMUM ECONOMY

The upset process is well suited to produce articles at or near the finished sizes; thereby reducing the amount of raw material needed. This saving, in material only, can run as high as 80%.



MATERIAL—We can form Rounds, Squares, Hexs, of steel, monel, stainless, bronze, hastalloy, etc. in sizes from 3/8" to 3" diameter.

For full details write for our Upset Forgings Bulletin.

THE CHAMPION RIVET COMPANY
CLEVELAND 5, OHIO EAST CHICAGO, INDIANA

Personals . . .

D. T. Stanton, Jr. recently resigned as instructor in chemistry at Oakland Junior College to devote his full time to corrosion study as a chemist for Eureka Chemical Co., San Francisco. Mr. Stanton was employed by the company on a part-time basis while he was teaching.

Donald P. Kohorst is now employed by Jet Propulsion Laboratory of Pasadena, Calif., as an associate research engineer in the materials research section. The laboratory is a subsidiary of California Institute of Technology, performing missile research for Army Ordnance.

Peter Dowbor, a graduate from Illinois Institute of Technology, has completed the graduate training course of Allis Chalmers Mfg. Co., Milwaukee, and is working as a metallurgist in the company's research laboratories.

Stanley Weiss has accepted a new position as supervisor of the PED welding laboratory in the aircraft gas turbine division of General Electric Co., Evendale, Ohio.

Robert J. La Porte was recently transferred from the Hanford Atomic Products Operations of General Electric Co., Richland, Wash., to the company's San Jose, Calif., Project, where he is conductor of photographic development work in Bldg. 2 of the Vallecitos Laboratory for the remote handling cells.

Walter R. Gretz, a June 1957 graduate of the University of Pittsburgh School of Mines, joined the Universal Div., Universal-Cyclops Corp., Bridgeville, Pa., as a metallurgical engineer in mill metallurgical control, attached to the electric furnace department.

Dean J. Deakyne has been assigned to the metropolitan New York and Connecticut area as a sales engineer for Parker Appliance Co., Cleveland. For the past three years, Deakyne was sales engineer in the east central Ohio territory for E. F. Houghton & Co., Philadelphia, and prior to that time was performing research work for Sun Oil Co.

B. L. Gumm is now supervisor in inspection for Convair Div. of General Dynamics, Inc.

Any similarity to a real life company is purely intentional



How does the master mechanic avoid tons of trouble?

When Flint N. Steele got his first job, he was determined to set the world afire. He had lots of spark — went on to big things. Today, he's one of the mighty over at Mighty Metals — master mechanic, to be exact.

MM rolls heavy tonnage in the course of a year. You never catch *them* with their plants down! And you never will, if Flint Steele has his way.

"No peanut-brittle part failure is going to foul up our production schedules!" is the way he puts it. Or words to that effect.

Now if you've ever seen a high-speed, continuous rolling mill, you know that it develops more impact, leverage, and load than a ringful of wrestlers. Several million instantaneous inch-pounds is nothing! (That's nothing?) Guarding against costly downtime is a mighty weighty problem indeed.



One way that Flint does it is by insisting on Ampco Metal at all critical points; for instance: (1) in the screw-down nuts; (2) in the screw-down worm wheel; (3) in the slippers (universal-joint bearing segments); (4) in the breaker blocks.

Ampco Metal is a uniform-quality copper-base alloy of such special yet sound structure that it withstands severe pressures and shock—and the abrasive action of powdered scale. It resists corrosion, so avoids the extra expense of special lubrication.

These characteristics make Ampco Metal especially suitable for use also in wearplates, pickling operations, and other production applications.

Where can Ampco save money for *you*? Talk it over with your nearby Ampco field engineer. And write for Bulletin 33 today. *Ampco Metal, Inc., Dept. MP-9, Milwaukee 46, Wisconsin (West Coast Plant: Burbank, Calif.)*

AMPCO®

AMPCO® METAL

The metal without an equal

G-3

Continuous CIRC-AIR Tempering

AT ± 5° F.

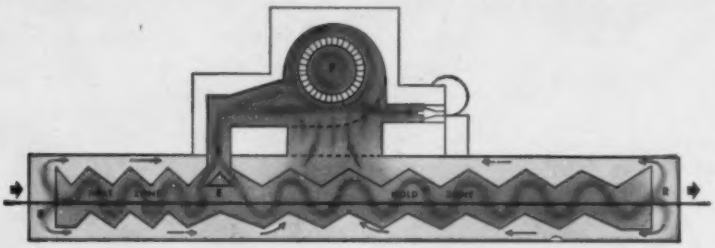


Industrial's "Circ-Air" tempering furnace is the most efficient heating machine ever designed.

The turbulent recirculation of hot gases through and around the work insures maximum and uniform heat transfer. Proper channeling of the hot gases to the work prevents wasteful dissipation of heat; and puts heat where it is needed — on the work.

A "Circ-Air" processing 2000 lbs. per hour at 1300° F., holding ±5° F., forces 14,500 C. F. M. of hot gases through the work. "Circ-Air" heating is recirculation at its best.

The continuous "Circ-Air" is suitable for heating steel, brass, aluminum and cast iron at temperatures up to 1450° F.



WHY THE CIRC-AIR IS THE BEST TEMPERING FURNACE!

The work is carried on a continuous conveyor. Loading can vary; ¼" bolts are densely loaded up to 3" deep. Less dense loading may be 20" deep. A 3' x 21' "Circ-Air" tempers over 2000 lbs. per hour.

Hot gases from the combustion chamber "C" and recirculated gases returning from the work chamber mix in the fan area "F." Entering the heating area through "T" at control temperature, balanced heat is directed to the charge and discharge ends, and is returned to the mixing chamber. The continuous V construction of the metal liner forces the hot gases up and down through the load at high velocity. The hot gases in the heating zone flow counter to the work. Heat transfer is rapid. Equilibrium is reached at point "E", and ±5° F. is held the length of the holding zone. Heating is without temperature head.

"Circ-Air" furnaces have been built in widths up to 108 inches, in lengths up to 165 feet, for temperatures from 250 to 1450° F., and capacities from 200 to 16,000 lbs. per hour. *Send for Bulletin 13-A*

INDUSTRIAL
HEATING EQUIPMENT CO.

CIRC-AIR 3570 FREMONT PLACE, DETROIT 7, MICHIGAN • WALNUT 3-7000

PIONEERS AND STILL LEADERS IN RECIRCULATION

Personals . . .

Fred J. Poss has joined the metallurgical service organization, stainless steels, of the U. S. Steel Corp., Pittsburgh. Before his appointment to this post, Mr. Poss was supervisor of materials and processes engineering for the commercial atomic power department of Westinghouse Electric Corp.

Albert J. McConnell, until recently sales service engineer with the Philadelphia branch, Crucible Steel Co. of America, was appointed assistant branch manager of the Baltimore, Md., branch of the company.

Stanley Y. Ogawa has returned to the SAE Dept. of the General Electric Co., Lynn, Mass., after his release from the U. S. Army, and is presently working in the field of forged turbine buckets in the metallurgical engineering section of the Thompson Laboratory. While in the armed forces, Mr. Ogawa was stationed in Korea as an engineer maintenance and repair officer.

Fred W. Boynton has been named industrial products sales manager in the Great Lakes region of Reynolds Metals Co., with headquarters in Detroit. Mr. Boynton, who joined the company in 1947, was director of industrial markets in the Louisville, Ky., sales office.

John H. Nicklas is now affiliated with ACF Industries, Inc., Hyattsville, Md., as a nuclear engineer in the fuel element project group of the nuclear energy products division.

Robert J. Thompson is now employed by the Moos Valve Co., Inc., East Aurora, N. Y. He is working in the test department testing servo control valves for guided missiles and jet aircraft.

Howard J. Atkinson has transferred his sales activities for the Riverside Alloy Metals Div. of H. K. Porter Co., Inc., to Hartford, Conn., from Marlboro, Mass. This change was necessitated by the merger of the Alloy Metal Wire Div. and the Riverside Metal Div., both H. K. Porter Co., Inc., subsidiaries.

William Hershman is now employed as purchasing representative of the Electric Boat Div., General Dynamics Corp., Groton, Conn.



Beyond the Shadow of a Doubt

... with a

TINIUS OLSEN Super "L" UTM

Photo Courtesy Georgia Institute of Technology

Engineering students at the Georgia Institute of Technology are learning to transform classroom theory into practice for evaluating materials of all types. Using this wide clearance Olsen 120,000 lb. De Luxe Super "L", ultimate strength and other physical data is obtained quickly and easily. Even if too low a range capacity is chosen initially, it can be changed during the test with a flip of the SelecTrange switch.

Exclusive Olsen stabilized hydraulic piston design assures positive, accurate load application. The load is read easily on the illuminated, color coded SelecTrange dial, while stress-strain curves are automatically plotted by the electronic recorder.

For testing convenience, accuracy and flexibility at low cost, an Olsen Super "L" is your best testing machine investment.

Get the facts. Write for Bulletin 47 today.

Trademark
Reg. U.S. Pat. Off.

TINIUS OLSEN
TESTING MACHINE COMPANY
2030 EASTON ROAD • WILLOW GROVE, PA.
Testing and Balancing Machines

Do you need better ways to strip paint?

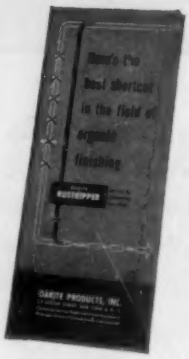
When tough finishes resist your present stripping methods, you may need help on some of these problems:



1 How to strip oil-base paints . . . synthetic enamels . . . alkali-resistant plastics . . . resin-base paints . . . japans . . . wrinkle finishes . . . nitrocellulose lacquers . . . alkyds . . . phenolics . . . ureas.

2 How to strip zinc chromate primers without etching aluminum.

3 How to strip paint from vertical surfaces and undersurfaces where thin-bodied strippers run off without doing their work.



4 How to strip metal parts that are too large to be soaked in tanks.

5 How to strip paint, pigment residues, phosphate coatings and rust in one operation.

6 How to strip paint from rejects, conveyor chains, racks and hooks in continuous operation.

Oakite has more than a dozen fine stripping materials for these and similar jobs.

FREE For information on problems 1, 2, 3 and 4 ask for a copy of "How to STRIP PAINT". For more on problems 5 and 6 ask for "Here's the best shortcut in the field of organic finishing". Write to Oakite Products, Inc., 28A Rector St., New York 6, N. Y.

OAKITE

MATERIALS · METHODS · SERVICE

SCIENCE

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

Personals . . .

H. G. Gearhart has been appointed chief metallurigst for the M. & A. Steel Co. to supervise the company's recently completed laboratory. Mr. Gearhart was formerly associated with the Clary Multiplier Corp., San Gabriel, Calif.

Robert L. Sisson has been promoted from assistant superintendent of the Gambrinus, Ohio, Bearing Factory of the Timken Roller Bearing Co., Canton, Ohio, to superintendent of the factory. Mr. Sisson, who came to Timken in 1937, was assistant superintendent of the Gambrinus factory before his promotion.

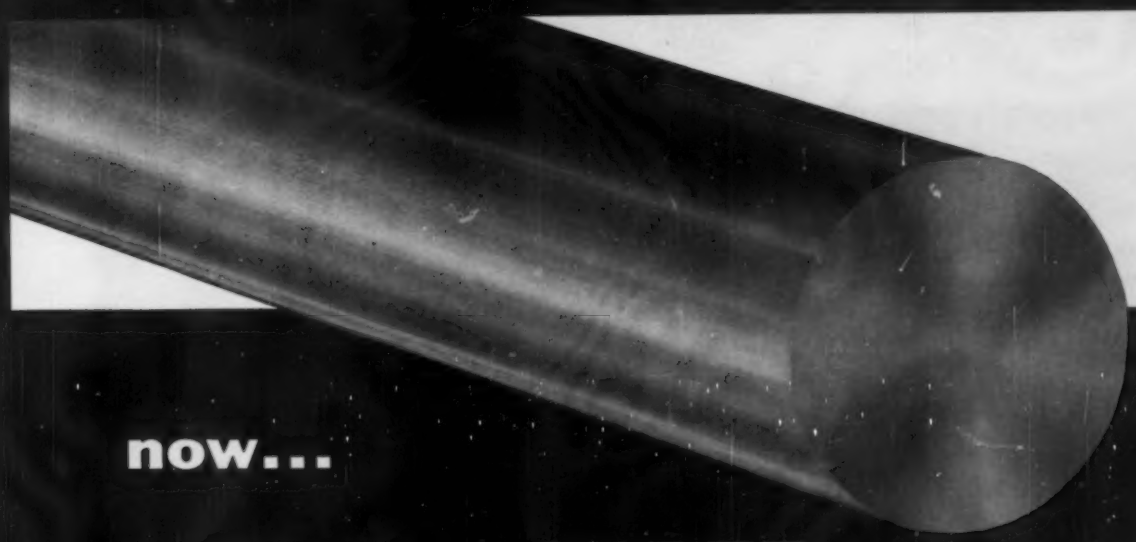
Leslie A. Cretty has been given a new assignment as manager of product development at the Waterbury Mfg. Co. plant of Chase Brass & Copper Co., Waterbury, Conn. Until recently, Mr. Cretty was in the industrial engineering department at the Chase home office.

E. P. Schweitzer is currently employed by the Copperweld Steel Co., Warren, Ohio, as service engineer for the company's hot mills. He was formerly connected with the Youngstown Sheet & Tube Co.

Louis A. Carapella was named technical director of the Jessop Steel Co., Washington, Pa., and in that position will be concerned with all technical aspects of production at all operations, including the home plant and the recently acquired Green River Steel Corp., in Owensboro, Ky. Dr. Carapella previously was a research director at the Metal Div. Research Center of Continental Can Co., Chicago, and in addition has held key positions at the atomic power division of Westinghouse Electric Corp., Mellon Institute of Industrial Research, and the Naval Research Laboratory.

John H. Froelich, an employee of the Universal-Cyclops Steel Corp., Bridgeville, Pa., for 22 years, has been named manager, production control. In his new capacity, he will have functional direction for production planning and scheduling activities at both the Bridgeville and Titusville, Pa., plants.

John W. Natwick joined the American-Standard Corp., in Redwood City, Calif., as a metallurgist.



now...

we've put COPPER into STRESSPROOF® steel bars



and the pennies you save add up to dollars!

New Copper Controlled Chemistry improves machinability, gives added wear resistance, and resists corrosion

Production increases by as much as 15% to 50% have been achieved in customer tests comparing STRESSPROOF with and without copper.

The controlled addition of copper to the STRESSPROOF chemistry improves machinability, gives added wear resistance, and resists corrosion. In addition, yield strength is guaranteed . . . 100,000 p.s.i. in sizes through 2" and 90,000 p.s.i. in sizes over 2"—*and* STRESSPROOF requires no heat treating.

JUST PUBLISHED: A new engineering report, "The Effect of Copper, Abnormally Heavy Drafts, Furnace Treatment and Die Practice on STRESSPROOF Steel Bars." Copies are available on request.





La Salle STEEL CO.

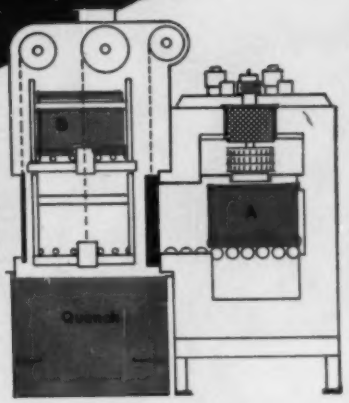
1424 150th Street, Hammond, Indiana

Sealed Cycle.....

A Dow Furnace FIRST for Batch-type controlled atmosphere furnaces.

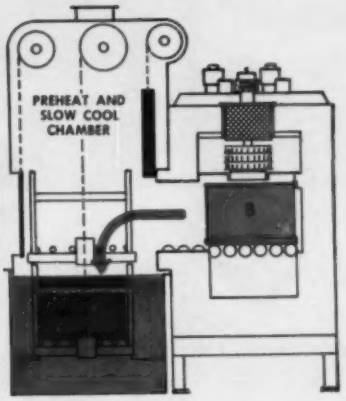
Step 1–LOADING CYCLE

Box A containing full furnace load of parts processing in work chamber. Box B—fully loaded, pre-heats in the upper vestibule. Box C—fully-loaded, waits on conveyor.



Step 2–QUENCHING CYCLE

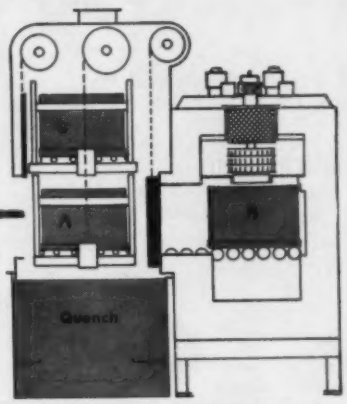
Box A completely processed, moves out to elevator and is lowered into quench; bringing preheated Box B to loading level. Box B is pushed into heat chamber and door is closed.



Step 3–RELOADING CYCLE

After proper interval, outer door is opened. Box C is placed on upper elevator and raised to pre-heat position as Box A is lifted from quench and removed from lower elevator.

Sealed Cycles' double door seal affords complete flexibility of processing without exposing heat chamber to air contamination.



Upper vestibule is easily adapted for slow cooling. Quench is adaptible for interrupted quenching.

DOW FURNACE COMPANY

12045 Woodbine Ave., Detroit 39, Mich.
Phone: KEnwood 2-9100

First WITH MECHANIZED, BATCH-TYPE, CONTROLLED ATMOSPHERE FURNACES

Personals . . .

Harold O. Ripple has been named district chief clerk at Republic Steel Corp.'s Warren, Ohio, plant. Mr. Ripple, who has been with the company since 1933, was assistant superintendent of quality control until taking over his new assignment.

C. E. Perkins has been promoted to vice-president of Superior Heat Treating Co., Fort Worth, Tex.

David L. Sponseller has assumed the duties of superintendent of the maintenance department of the Hamilton, Ohio, plant of Armco Steel Corp. Coming to Armco in 1929 as a draftsman, Mr. Sponseller was named assistant superintendent of maintenance in 1946.

L. G. Klinker has been reassigned from deputy chief of the national engineering branch, Ordnance Ammunition Command, Joliet, Ill., to the U.S. Army Research & Development Liaison Group in Frankfurt am Main, Germany. This group is designed to support research which is advanced, unique or not available in the United States, and its work is closely coordinated with the office of Naval Research in London, and the European Office of the Air Research and Development Command in Brussels.

E Leonard Kern is employed by Crucible Steel Co. of America at the Midland, Pa., works as a practicing engineer in the melt shop.

Frank Jacobs has accepted an assignment as supervisor of engineering metallics for Temco Aircraft Corp., Dallas, Tex. Until recently he was head engineer of the metallurgical laboratory of Boeing Aircraft Co., Wichita, Kan.

Vernon A. Sturm is now with the Inland Testing Laboratories Div., Cook Electric Co. as liaison engineer and metallurgical consultant.

W. J. Lohmeyer, Jr., has joined the executive sales staff of Jessop Steel Co., Washington, Pa. Mr. Lohmeyer has had 14 years experience in the steel industry, including several years with U.S. Steel Corp., and more recently served as sales manager in the Pittsburgh district for Latrobe Electric Steel Co.



Shock wave around a simulated missile

SUPERALLOYS for supersonic performance

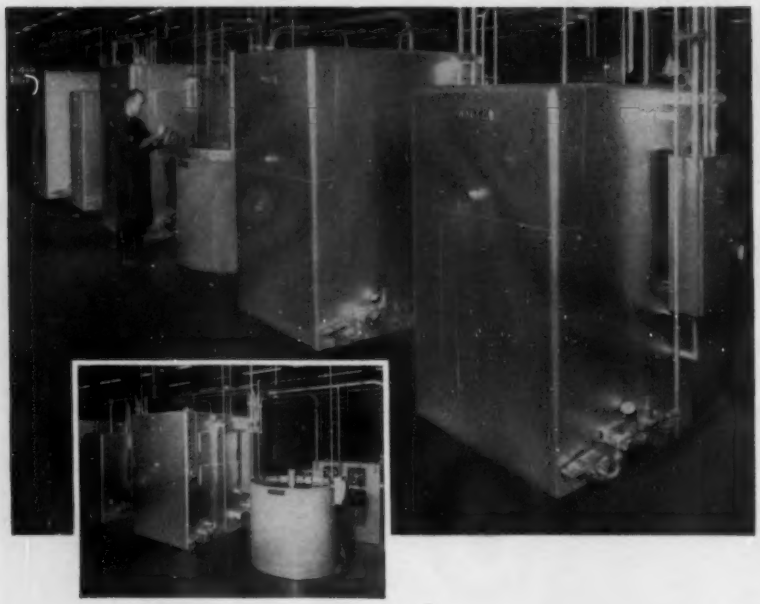
We develop them. And through modern vacuum melting produce them to the closest possible limits of chemical control and uniformity of mechanical properties for use in such critical components as aircraft turbine blades, buckets and skin material for missiles and rockets. UDIMET 500, one of our well established vacuum melted alloys, combines unsurpassed stress-rupture life with excellent ductility and fatigue strength in the 1200°F to 1800°F range. At 1200°F, for example, its tensile strength is 180,000 psi —at 1600°F, 100,000 psi. For further information concerning applications of these superalloys to your products, write to address below.

VACUUM MELTING
provides these properties

- *High temperature corrosion resistance*
- *Increased ductility*
- *Extreme cleanliness*
- *Precise chemical control*
- *Longer stress-rupture life*
- *Increased tensile strength*
- *Better fatigue resistance*
- *Greater yield strength*
- *Greater impact resistance*
- *Greater creep properties*

UTICA METALS DIVISION OF KELSEY-HAYES

UTICA DROP FORGE & TOOL DIVISION — KELSEY-HAYES CO., UTICA 4, NEW YORK



Waltz furnaces have

the forward look

at Chrysler Corporation

When equipping Chrysler Corporation's new TorqueFlite automatic transmission plant at Kokomo, Indiana, Chrysler engineers demanded equipment capable of top performance. WALTZ Furnaces were selected for the automotive tool room.

In addition to delivering the performance required, Waltz Furnaces also are attractive, smooth, easy-to-clean. Outer shells reach all the way to the floor to prevent unsightly and dangerous clutter usually found under ordinary furnaces. Waltz doors fit flush and tight, are opened with a convenient foot pedal control. Cabinet-type control panels are neatly wired to terminal blocks for easy installation.

Performance-appeal? Waltz has plenty. Just try to match the amazing versatility of a Waltz furnace. Originally installed by Chrysler just to handle the needs of the automotive tool room, the furnaces shown in the illustration were soon called on to handle many pilot parts, as well as regular production runs. Chrysler stayed right on schedule. So can you!

A complete line of Waltz standard or special heat-treating furnaces, using all types of fuels, is built to suit your requirements. Write for comprehensive illustrated bulletins to Dept. W.

Choice Distributor Territories Now Open

Waltz FURNACE COMPANY

SYMMES STREET • CINCINNATI, OHIO

Personals . . .

John B. Adamec has joined the staff of the International Nickel Co. research laboratory at Bayonne, N.J., as a research metallurgist in the field of platinum metals. For the past seven years, Mr. Adamec was research metallurgist and chief metallurgical engineer with the Sintercast Corp. of America, Yonkers, N.Y.

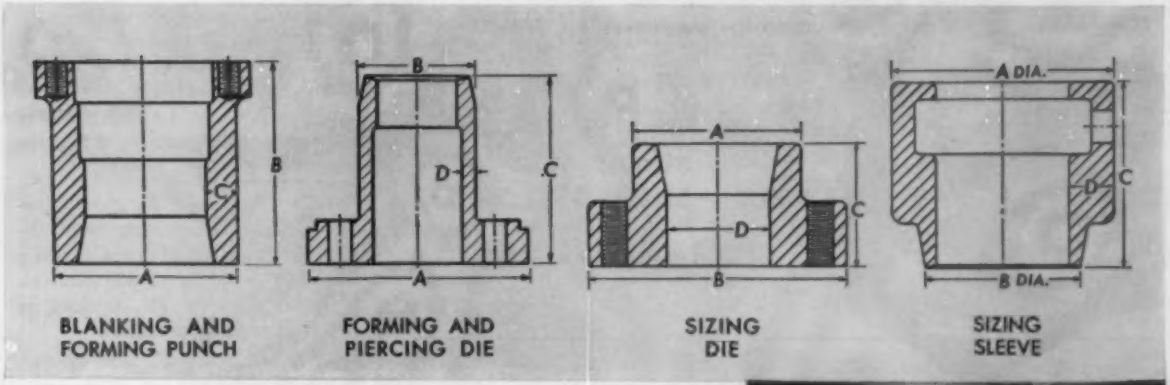
John N. Moore, formerly product supervisor for Virgo Salt and Fluorolube in the sales department of the Hooker Electrochemical Co., Niagara Falls, N.Y., has been promoted to supervisor, jobber sales. He joined the manufacturing section of the research department of Hooker in 1941 and eight years later transferred to the sales department.

Patrick G. Russell has been assigned to Brookhaven National Laboratory, Upton, N.Y., as permanent Babcock & Wilcox representative in connection with a radiation test loop for the liquid metal fuel reactor equipment.

Arthur J. Abrams has left Secon Metals Corp, New York, to accept a position as metallurgist in the technical control department of Handy & Harman, New York.

Six members were among those honored by the American Foundrymen's Society at the society's annual A.F.S. Castings Congress and Engineering Castings Show in Cincinnati. **Charles C. Donoho** was the recipient of the Peter L. Simpson Gold Medal "for outstanding contributions to the Society and to the ferrous castings industry, especially in the fields of gray iron, nodular iron and steel". Mr. Donohoe is chief metallurgist of the American Cast Iron Pipe Co., Birmingham, Ala. **Richard W. Heine** and **Arthur E. Schuh** were among the first four men to be presented with the new A.F.S. Awards of Scientific Merit. An associate professor of mining and metallurgical engineering at University of Wisconsin, Mr. Heine was recognized for his research on malleable cast iron, while Mr. Schuh, director of research and development at the U.S. Pipe and Foundry Co., Burlington, N.J., received the award for his cupola research investigations and development of the society's basic ferrous publications.

Do you make ring-shaped tool steel parts like these?



BLANKING AND FORMING PUNCH | FORMING AND PIERCING DIE | SIZING DIE | SIZING SLEEVE

Graph-Mo Hollow-Bar® can cut your costs because the hole's already there

Eliminates drilling, machines faster



YOU start with finish boring when you use Graph-Mo Hollow-Bar®. The hole's already there! Because drilling is eliminated, you cut costs and speed production. And you get a tool steel that machines faster, wears longer, gives more stability.

Graph-Mo machines faster than ordinary tool steels because of the free graphite in its structure. And there's far less tendency to pick up, scuff or gall.

Reports from users show that Graph-Mo outwears other tool steels three to one on the average. That's because of the combination of free graphite and diamond-hard carbides in Graph-Mo's structure.

And you won't find a more stable tool steel than Graph-Mo. Proof: after 12 years of use, a master plug gauge machined from Graph-Mo showed less than 10 millionths of an inch dimensional change.

Specify new Graph-Mo Hollow-Bar for all your ring-shaped tool steel parts. You'll save time and money, have a better finished product. It's available in O.D. from 3 to 16 inches with many wall thicknesses.

For more information write: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO".

TIMKEN *Fine Alloy* STEEL

TRADE-MARK REG. U.S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

See the first Timken Televent hour, in color, "Eleven against the ice—story of the Antarctica Turnpike". NBC-TV, Monday night, Sept. 23rd.



Make these

30 DISTRICT SALES OFFICES

your First Call for

WYCKOFF

QUALITY CONTROLLED

COLD FINISHED STEELS

CARBON • ALLOY • LEADED

ALBUQUERQUE, N.M.
Harry Ranville—*Phone:* 2-4127
AMERICUS, GA.
T. G. Walker—*Phone:* 3579
BIRMINGHAM, ALA.
C. I. Craig Company—
Phone: Tremont 9-4673
BOSTON, MASS.
A. F. Erikson—*Phone:* Reading 2-1382
BUFFALO, N. Y.
J. E. Allen—*Phone:* Spring 6400
CEDAR RAPIDS, IOWA
A. W. Eastin—*Phone:* Empire 5-2388
CHICAGO, ILL.
E. C. Rock—*Phone:* Bishop 7-6700
CLEVELAND, OHIO
C. B. Thoburn—*Phone:* Main 1-8662
DAYTON, OHIO
G. H. Rehling—*Phone:* Adams 6571
DENVER, COLORADO
Paul R. Spencer Co., Inc.
Phone: Keystone 4-3293
DETROIT, MICH.
E. C. Koester—*Phone:* Trinity 2-2002
FARGO, N. D.
E. H. Thompson—H. M. Hanson
Phone: 2-6493
FORT WORTH, TEXAS
C. A. Fischer
Phone: Fannin 6402 or 5435
GREENSBORO, N. C.
K. O. Brown & Co.—*Phone:* 3-5973
HARTFORD, CONN.
Lane Johnston
Phone: (Putnam) Walnut 8-2754
HOUSTON, TEXAS
Harry W. Renick, Jr.
Phone: Mohawk 7-8249
KANSAS CITY, MO.
Fred H. Hoener—*Phone:* Valentine 1-7134
LOS ANGELES, CALIF.
Fred H. Currie, Inc.
Phone: Richmond 9-0291
MILWAUKEE, WIS.
H. L. Schultz—*Phone:* Broadway 6-4441
MINNEAPOLIS, MINN.
George E. Sandberg Co.
Phone: West 9-6745
NEWARK, N. J.
W. A. Thompson—*Phone:* Bigelow 8-2277
PHILADELPHIA, PA.
E. H. Carmany—*Phone:* Locust 4-3060
PITTSBURGH, PA.
General Office—*Phone:* Atlantic 1-2750
PUTNAM, CONN.
N. A. Robinson—*Phone:* Walnut 8-2754
READING, MASS.
A. F. Erikson—*Phone:* 2-1382
SALT LAKE CITY, UTAH
Paul R. Spencer Co., Inc.
Phone: Ingersoll 6-3406
SAN FRANCISCO, CALIF.
Thos. S. Hutton & Son
Phone: Exbrook 2-7017
ST. LOUIS, MO.
E. R. Hensel Co.—*Phone:* Townsend 5-1900
SEATTLE, WASH.
M. M. Mossman—*Phone:* Seneca 5393
TOLEDO, OHIO
Browne-Sudhoff—*Phone:* Lawndale 6256

In this age of specialization nothing serves like the highly trained craftsmanship and concentrated experience of the specialist. Wyckoff has specialized in fine quality cold finished steels—rounds, squares, hexagons, wide flats and precision shafting—for over 35 years.

SPECIALISTS IN COLD FINISHED STEEL ENGINEERING

WYCKOFF STEEL CO.

GENERAL OFFICES:
Gateway Center, Pittsburgh 30, Pa.
Branch Offices in Principal Cities
Works:
Ambridge, Pa., Chicago, Ill., Newark, N.J., Putnam, Conn.

AMERICA AND STEEL STEEL CENTENNIAL GROW TOGETHER

WYCKOFF STEEL PRODUCTS

CARBON, ALLOY and LEADED STEELS • TURNED and POLISHED SHAFTING • TURNED and GROUND SHAFTING • WIDE FLATS up to 12" x 2" and 14" x 1¼"

ALL TYPES OF FURNACE TREATED STEELS

Personals . . .

F. W. French II has organized a new corporation to make plain and fabricated copper, brass, aluminum and steel tubing. The company, located in Newtown, Conn., is called the F. W. French Tube Co. For the last 13 years, Mr. French was technical supervisor of the French Small Tube Div., American Brass Co., Waterbury, Conn., resigning in May 1956 to become president of the new company.

John E. Anthony, recently released from active duty with the U. S. Army Chemical Corps, is now a metallurgical engineer with Latrobe Steel Co., Latrobe, Pa., working on problems in vacuum melting.

M. T. Rowley resigned as chief metallurgist of Ohio Injector Co., Wadsworth, Ohio, early this year to become assistant chief engineer of the Barberton, Ohio, division of Rockwell Mfg. Co.

Joseph C. Coyne was appointed branch sales manager early this year for the Aluminum Co. of America, Ft. Wayne, Ind., sales office. He has been with the company since 1940.

B. M. Hamilton now holds the position of chief metallurgical engineer for Atlas Steels Ltd., Welland, Ont. An employee of Atlas since 1944, Mr. Hamilton's new duties will include directing company metallurgical service, process metallurgy and market development.

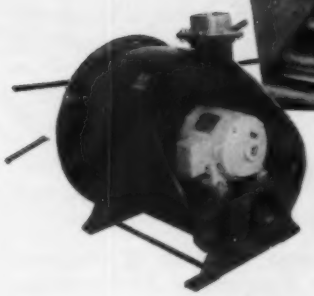
Frank L. Wright has been named director of engineering and research for the Coolidge Corp., Middletown, Ohio. Formerly works manager with Norma - Hoffmann Bearings Corp., Stamford, Conn., Mr. Wright more recently served as manager and consultant with Pneumafil Corp., Charlotte, N.C.

Seymour B. Donner has accepted the post of plant manager of Deemer Steel Casting Co., New Castle, Del. In this capacity, he will be responsible for all foundry operations which produce electric steel castings for marine and industrial use. Mr. Donner has had more than 15 years experience in the foundry field, last serving as chief manufacturing engineer and assistant foundry manager at Yale and Towne Mfg. Co., Stamford, Conn.

again



Reliable SPENCER Blowers



On original equipment . . . or for replacement . . . men who *know metals* specify SPENCER Blowers.

This Drever heat treating line — largest of its type in the world (capacity: 21½ tons of plate per hour)—utilizes a total of 26 Spencer Blowers. The hardening furnace (charging end shown above) is equipped with 11 Spencer Blowers ranging from 200 to 4,100 C.F.M.; the tempering furnace has 15 Spencer blowers delivering from 450 to 1,900 C.F.M.

Rugged reliability . . . simple construction . . . assured uniform pressure at varying volumes . . . mounting that requires no special foundation — these are a few of the reasons why SPENCER IS PREFERRED.



Request Bulletin 126-A containing complete information and specifications on Spencer Blowers.

The SPENCER TURBINE COMPANY
HARTFORD 6, CONNECTICUT

SPENCER HARTFORD

OTHER QUALITY SPENCER PRODUCTS


STATIONARY VACUUM SYSTEMS


PORTABLE VACUUM CLEANERS

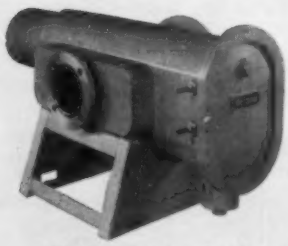

PNEUMATIC CONVEYING SYSTEMS

Cr, Hf, Ir, Mo, Nb, Os, Pd, Pt, Re, Ta, Ti, V, W, Zr

Get pure vacuum melts of these metals *in minutes!*



The Heraeus Vacuum Arc Melting Furnace Model VA-L200C, smallest of a line of Heraeus Furnaces sold by CEC.



This Roots pump maintains low, vapor-free pressures. A motor operating within the vacuum drives its rotary frictionless pistons.

With this new Heraeus Arc Melting Vacuum Furnace, the VA-L200C, you can get vacuum melts in "buttons" or ingots.

You can get them of Titanium, Zirconium, Tungsten, and other metals or alloys with high melting temperatures. You can get them fast and pure.

Super-fast mechanical pump—A Roots mechanical vacuum pump pulls pressures in the furnace down to 5×10^{-4}mm Hg—*fast*.

Its throughput of 10,400 micron CFM at 10 microns easily handles sudden gas bursts encountered with certain metals.

No oil contamination—The Roots pump's frictionless rotary pistons require no oil sealing. There can be no contamination from backstreaming vapors in the system.

No crucible contamination—The Heraeus furnace has a water-cooled, copper crucible which cannot contaminate the melt.

Fixed or consumable electrodes—You may use either fixed electrodes of tungsten or metallic carbides, or consumable electrodes of the metal you are melting.

This Heraeus furnace has many other features valuable in laboratory or small-scale production, including exceptional economy—operating either under vacuum or with an inert gas atmosphere.

Heraeus of Hanau, Germany, has licensed CEC as exclusive agent for Heraeus Arc Furnaces (and Roots Pumps) in this country. Complete details in our Bulletins P8-20 and P4-28.

Consolidated Electrodynamics

Rochester Division, Rochester 3, N. Y.

formerly Consolidated Vacuum

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

Personals . . .

Harold N. Lurie is a staff assistant on special projects of the research department of Cummins Engine Co., Ltd., Shotts, Scotland, a wholly owned subsidiary of Cummins Engine Co., Inc., Columbus, Ind. Mr. Lurie was sent to the Scotland plant to set up the chemical and metallurgical laboratories and will probably be stationed there for two years.

Steve Morykwas has been appointed superintendent, quality control laboratory, Utica Bend Corp. Mr. Morykwas was connected with Packard Motor Car Co., Detroit, before this appointment.

L. Robert Haslip, formerly associated with the Ritter Co., Inc., Rochester, now holds the post of welding engineer with the Pfaudler Co., Rochester, N.Y.

C. P. Doherty, president and general manager of the Despatch Oven Co., Minneapolis, Minn., has become a partner of **W. C. Matheson** in the Matheson-Doherty Co., San Francisco. Mr. Matheson is currently chairman of the Golden Gate Chapter.

Howard K. Schmuck, Jr., has been promoted to assistant manager of mining supply sales of the Colorado Fuel and Iron Corp., Denver, Colo. Mr. Schmuck was affiliated with Haynes Stellite Co., a division of Union Carbide Corp., in Houston, Tex., before joining Colorado Fuel and Iron as a product engineer.

George A. Roberts, vice-president of technology for Vanadium-Alloys Steel Co., Latrobe, Pa., was elected board chairman and president of the Metal Powder Assoc. at the association's annual meeting. Dr. Roberts has headed Vanadium-Alloys' powder metallurgy department since it was first organized shortly after World War II. He served as president of the American Society for Metals in 1954-55.

Stanton L. Reese is currently a staff member of the nuclear reactor materials department of the Davison Chemical Co., division of W. R. Grace and Co., Baltimore, Md. Mr. Reese previously was affiliated with the National Lead Co. of Ohio, Cincinnati, Ohio.



PUMP HOUSING is made precisely and accurately from REFRAX® silicon-nitride-bonded silicon carbide. It is used in handling chemical abrasive slurries where corrosion resistance is most important.

Refractories . . . to surpass **metals**

What material combines *all* the following properties? Corrosion resistance so that it is not wet by molten aluminum, and resists attack by most acids; abrasion resistance that prevents wear by both high velocity particles and sliding heavy masses; the ability to withstand temperatures to 3000° F; hot strength so high that at 2450° F its modulus of rupture is 5600 psi?

What material *combines* all these properties? Obviously not a metal, not even a cermet. It is one of Carborundum's special refractories — REFRAX® silicon-nitride-bonded silicon carbide. This material can be precisely formed to tolerances of ±0.005 in./in. with external and internal threads. Finish resembles that of a cast iron part.

Your high temperature problem, no matter how complex it may be, can almost certainly be solved with one of the scores of super refractories by Carborundum. For assistance, write for these three booklets:

CARBORUNDUM
Registered Trade Mark

MAIL THIS COUPON TODAY

Refractories Division,
The Carborundum Company, Perth Amboy, N. J., Dept. M97

Please send me:

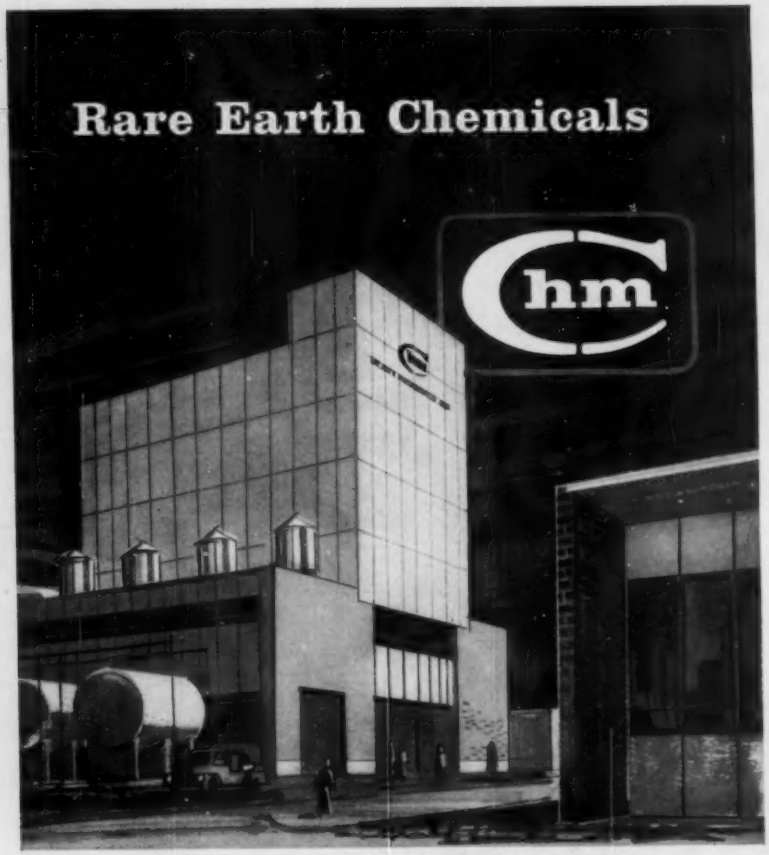
- ☐ Current issue of Refractories magazine on REFRAX®
- ☐ Reprint of article in Product Engineering, Feb. '57 entitled "Nitride-bonded silicon-carbide bridges gap between metals and ceramics".
- ☐ Bulletin on REFRAX®

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____



HEAVY MINERALS CO. is unique in the rare earth chemical field. It is a complete domestic integrated operation from mine to consumer. HMC's new Chattanooga plant is the first in the U. S. to attack monazite ore, from its own domestic mines, with caustic soda. This caustic attack fits the diverse problems of rare earths better than any other process. HMC is thus able to insure its customers uniform quality of finished product by controlling its own raw material and using the most reliable and modern processing technique.

Rare earths are rare today in name only. Although the word "rare" seems to imply high cost, mixed rare earth chemicals are available today in quantity at reasonable prices.

HMC supports its processing operations with a vigorous research program designed to improve process technique and product use. Its research and development department welcomes the chance to share its technology with rare earth users and potential consumers.



Send for free informative booklet

HEAVY MINERALS CO.

RARE EARTH CHEMICALS • THORIUM • HEAVY MINERALS

4000 NORTH HAWTHORNE STREET, CHATTANOOGA, TENN.
NEW YORK SALES OFFICE: 261 MADISON AVENUE, N. Y. 16, N. Y.

Personals . . .

Richard W. Nuffort has been elected secretary of Whitehead Metal Products Co., Inc., New York. Associated with Whitehead since 1926, he has served as manager of the company's Philadelphia office since 1951.

Leon Hurwitz, a member of the staff of Hamilton Watch Co., Lancaster, Pa., for 10 years, has been assigned the post of product manager of the metals processing department, a section of the company which performs metals research and processing services for more than 200 companies throughout the country. In his former position as chief metallurgist, Mr. Hurwitz was in charge of the company's science laboratories.

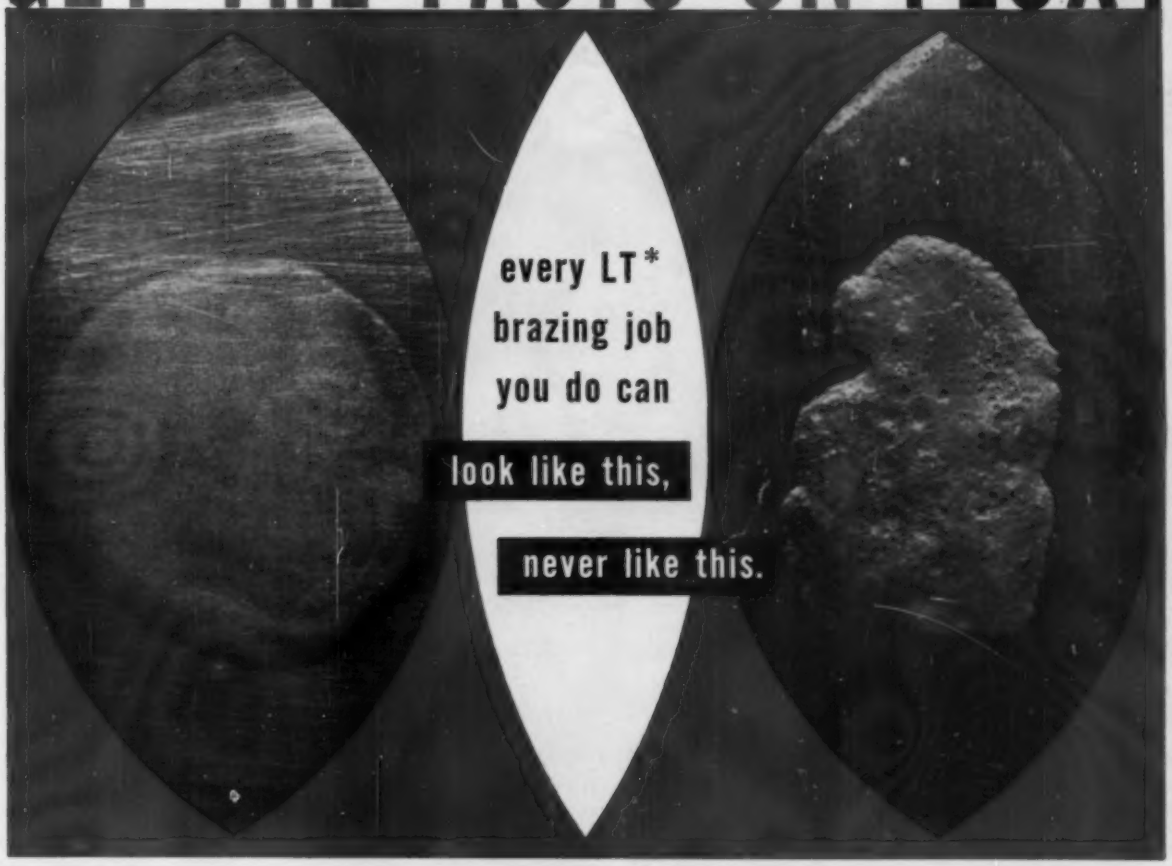
Thomas H. Wickenden received an honorary degree of doctor of science from Denison University at the university's June commencement exercises, in recognition of his substantial contributions to the field of metallurgy. Mr. Wickenden retired in 1954 as vice-president and manager of the development and research division of the International Nickel Co., Inc., New York, after 32 years with the company.

George V. Smith has been named director of metallurgical engineering at the school of chemical and metallurgical engineering at Cornell University. Dr. Smith joined the Cornell faculty in 1955 as Francis Norwood Bard professor of metallurgical engineering, after 14 years with the U.S. Steel Corp., Kearny, N.J., research laboratory. While associated with U.S. Steel, he taught graduate night courses in metallurgy at Polytechnic Institute of Brooklyn.

W. A. Sullivan, Jr., is district manager for the Mexico Refractories Co.'s (Mexico, Mo.) first Canadian office in Edmonton, Manitoba. **W. J. Patton** has been appointed district chief engineer for the Edmonton branch.

Kenneth G. Wood has left his position as lecturer in metallurgy at the College of Commerce & Technology, Sheffield, England, to take a similar position at the College of Technology, Art & Commerce in the School of Science, Oxford.

GET THE FACTS ON FLUX!



UNITED, PRODUCERS OF PHOSON & SIL-BOND, TAKES THE RISKS OUT OF FLUX SELECTION

Now, it's easy to be right every time. New United red label, black label or blue label Sil-Fluxes give you the assurance of perfect brazing results under all conditions.

The photos above, taken under exactly the same conditions, prove it!

The photo on the right illustrates the flux metal reactions which result when you use an inferior flux. Gas pockets. Voids. Cratering. Leaks and general failures. What was wrong with the flux? It could have been high surface tension, high viscosity, poor equilibrium, the wrong fluid density in relation to the brazing alloy density. It might have been a tendency toward secondary crystallization. Or, it could have been a combination of these factors.

Now, glance at the other photo. Perfect fluxing with new Sil-Flux. Compounded to 325 mesh, the finest available, Sil-Flux penetrates deeply, absorbs even the most difficult refractories and ferrous and non-ferrous oxides without secondary crystallization.

Your flux must be tailored for the brazing alloy you are using. Here's how to select the right Sil-Flux for the job:

Sil-Flux Red Label — 750°F to 1550°F — for lowest and controlled temperatures — superior on copper and its alloys.

Sil-Flux Blue Label—800°F to 1600°F—best all-purpose flux — excels on tightly fitted parts.

Sil-Flux Black Label — 1000°F to 1800°F — for higher temperature or prolonged heating.



Sil-Fluxes are available in ¼, ½, 1 lb. and 5 lb. jars and 30 lb. drums. Labels are boldly colored for easy identification.

Join Better By Brazing . . . Join Best With Phoson.

*L.T. — low temperature

UNITED WIRE

PROVIDENCE 7, RHODE ISLAND

COPPER, BRASS AND ALUMINUM WIRE AND TUBE . . . BRAZING ALLOYS, PHOSON, SIL-BOND



Personals . . .

Kenneth A. Trickett has accepted an appointment as senior mechanical engineer on the Pennsylvania Advanced Reactor Project of the atomic power department of Westinghouse Electric Corp., Pittsburgh. After moving to Canada from England in 1952, Mr. Trickett worked on the Chalk River reactor for two years and then served as head of the engineering department of Dowty Equipment of Canada Ltd. until coming to this country.

William C. Stewart has been chosen to head a recently established metallurgy department at the U.S. Naval Engineering Experiment Station, Annapolis, Md. The new department combines the work of the station's former metallurgical and welding laboratories. Mr. Stewart, a graduate of the University of Denver, was associated with the Queen City Foundry Co. in Denver before joining the Experiment Station in 1926. Four years later he became superintendent of the metallurgical laboratory, remaining in this capacity until his recent appointment.

Several members were included among the twelve technical leaders in the field of engineering materials who received Awards of Merit from the American Society for Testing Materials at the society's annual meeting in June. These awards were given to men who have rendered outstanding service to A.S.T.M., particularly in its technical committee work. **Donald L. Colwell**, director of laboratories for the Apex Smelting Co., Cleveland, **R. E. Penrod**, retired chief metallurgist, Bethlehem Steel Co., Johnstown, Pa., **Frank W. Reinhart**, chief of the plastics section of National Bureau of Standards, Washington, D.C., and **Francis G. Tatnall**, vice-president and general manager of the Tatnall Measuring Systems Co., Phoenixville, Pa., were all recognized for outstanding contributions to the society through their work on A.S.T.M. Committees.

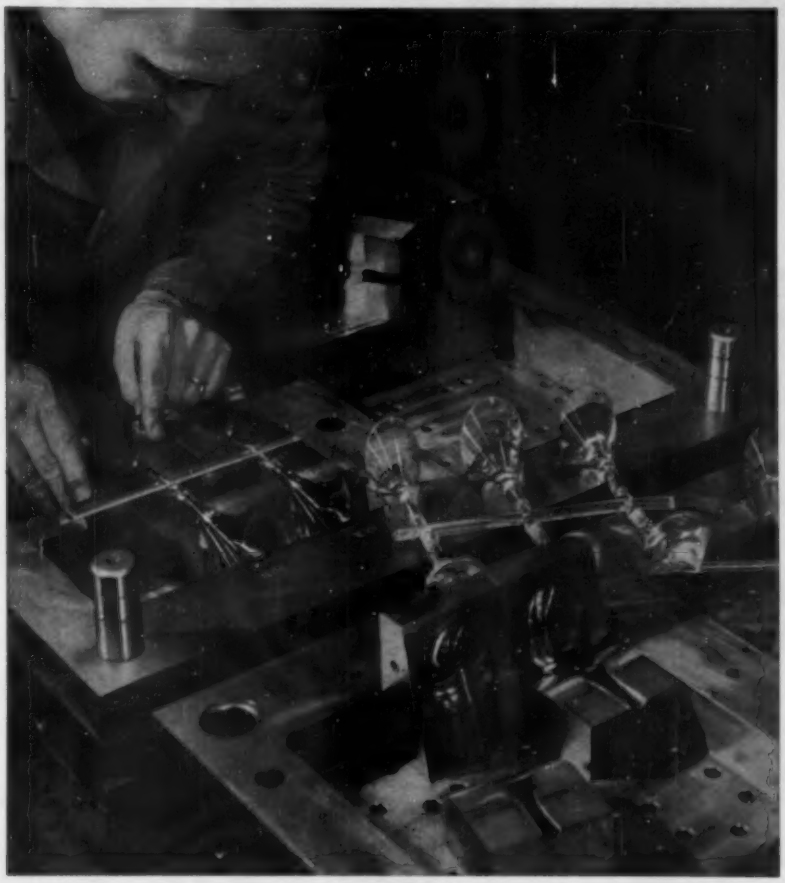
Carl O. Ericke has been chosen to manage the new mill-branch warehouse of the Carpenter Steel Co. in Detroit. In addition, **O. T. Thompson** will serve the new installation as branch manager.

Tool Steel Topics

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation



Injection Mold of Lustre-Die Makes Plastic Heels That Are Just So!

Here was the problem: to find a tool steel grade which would machine economically, have high mechanical properties, and still have the ability to take the high polish required for producing slick, eye-stopper heels of butyrate and lucite, for women's shoes.

The answer: Bethlehem Lustre-Die tool steel. This was the steel used by Charles Zapf & Company, Evanston, Ill., in producing the injection mold illustrated above. The steel was furnished by Peninsular Steel Co., our local tool steel distributor. According to Missouri Wood Heel Co., St. Louis, who produced the heels, it met every requirement with plenty to spare.

Lustre-Die is an ideal steel for making plastic parts because its properties enable it to take an unbelievably bright mirror-like polish. Not only is Lustre-Die the proper basic analysis for working with plastics—we further enhance it by alloy fortification. It is heat-treated by oil-quenching and tempering to augment its properties, and comes ready for machining and polishing.

Lustre-Die is an electric-furnace steel, carefully inspected to insure cleanliness. It is free from injurious porosity or surface pitting. What's more, there's no problem about inclusion-causing additions.

Lustre-Die tool steel is worth looking into. For full details, check with your friendly Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:



Follow These Hints When Drilling Small Diameter Holes

Drilling small diameter (1/16 in. and less) holes when making tools is an operation which often causes considerable trouble. Breakage of drills in partly drilled holes occurs frequently, leading to the suspicion that the tool contains "hard spots." Investigation of such complaints by cutting up the suspected tool practically never confirms the presence of hard spots in modern high-quality tool steels.

Trouble in drilling small diameter holes is nearly always mechanical in nature, and is usually due to too low a drill speed, or too great a feed, or both. In order to obtain the normal speed (surface feet per minute) for cutting edges, it is necessary to run small diameter drills at high speeds in comparison to large drills. A 1/16-in. diameter drill should turn at approximately 2000 rpm, for example, as compared to about 200 rpm for a 1/2-in. drill. Proper feeds for small drills are in the order of .001 in. to .002 in., as compared to about .008 in. to .012 in. for larger drills. Overfeeding and deep cuts produce longitudinal deflection or bending of the drill, which cause overloads resulting in drill breakage. Proper planning and maintenance of correct speeds and feeds will largely eliminate trouble encountered in drilling small diameter holes.

• • • • • • • •



LEHIGH H DIE BLANKS AXLE HOUSINGS

This Lehigh H die, hardened to Rockwell C61, blanked axle housings from 3/16-in. sheet steel, and produced 50,000 pieces before slight redressing was required. Lehigh H, our air-hardening high-carbon, high-chrome steel, was selected for this heavy-duty application because of its high wear-resistance, as well as for its minimum distortion in heat-treatment.

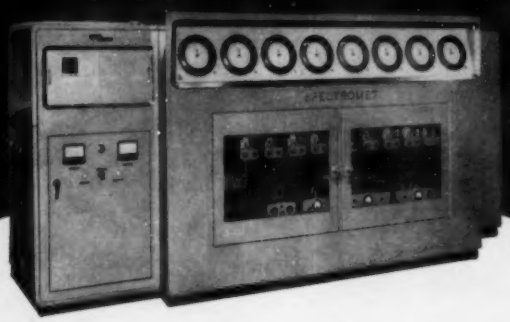


How can Analytical Equipment squeeze out more profit dollars?

By making rapid, accurate analyses — in seconds — on the production floor!

By eliminating losses caused by off heats!

By using the *Baird–Atomic* SPECTROMET!!!



Analyses of metals in production maintains a constant high level of quality control, at a production rate requiring minimum furnace time.

Another plus — the savings in alloys. The B-A Spectromet provides percent concentration within 60 seconds, thus less alloying materials are lost during meltdown. Speed and accuracy are inherent features of the B-A Spectromet.

The moment spent to write for full details will be well rewarded.

BAIRD ATOMIC

Baird–Atomic, Inc.

33 UNIVERSITY ROAD, CAMBRIDGE 38, MASS.

Personals . . .

Thomas E. Barlow and **Horace A. Deane** received the first Service Citation Awards of the American Foundrymen's Society at the society's annual Congress. The awards are made in recognition of "outstanding general service, primarily of a non-technical nature, to the society and the castings industry". Mr. Barlow is sales manager of Eastern Clay Products Div., International Minerals and Chemicals Corp., Chicago, while Mr. Deane is vice-president of Campbell, Wyant and Cannon Foundry Co., Muskegon, Mich.

W. K. Hile has been appointed a representative in the Southeastern states for the Gibson Electric Co., Pittsburgh, with headquarters in Charlotte, N.C. Mr. Hile has been a sales engineer representing industrial manufacturers for the last two years, and prior to that spent 15 years in the sales divisions of Westinghouse Electric Corp., Pittsburgh, and Hoskins Mfg. Co., Detroit.

Marian Balicki has assumed full-time duties as an engineer specialist in the department of physical metallurgy and ceramics at the Sylvania-Corning Nuclear Corp., Bayside, N.Y. Dr. Balicki was head of the metallurgical engineering division at the Polytechnic Institute of Brooklyn before accepting this post.

Joseph B. Shelby has retired as assistant vice-president in charge of sales for Driver-Harris Co., Harrison, N.J., after 38 years of service. Joining the company in 1917, Mr. Shelby held various managerial positions until 1944 when he was named assistant vice-president of the company; he was assigned the additional duties of sales manager in 1956. **Kenneth M. Hobbie**, former assistant sales manager, will succeed Mr. Shelby as sales manager and vice-president. In addition, **Frank L. Driver III** has been promoted from assistant vice-president to administrative vice-president.

Felix E. Wormser has resigned as assistant secretary of the Department of Interior. During his four years as assistant secretary of mineral resources, Mr. Wormser had supervision over the Bureau of Mines, the Geological Survey, Div. of Geography and Div. of Oil and Gas.

Case No. 42

Kemp Immersion Heating Gets Top Results for Signode Steel Strapping Company



How Signode Steel Strapping Co. tempers 650 feet of steel strap every minute

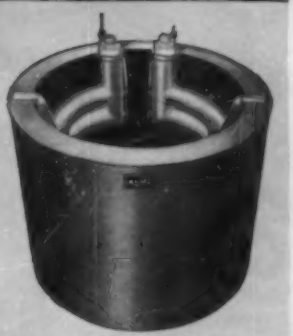
At the Signode plant in Sparrows Point, Md., turning out up to a thousand miles of steel strap daily calls for fast, efficient production line techniques. One highly important phase in the final processing is the tempering bath. Here, Signode called on Kemp Engineers to supply the 15 ton, gas-operated Immersion Melting Pot shown above. Now steel strap is uniformly tempered at the rate of 650 feet per minute.

Kemp Offers More Advantages

By installing Kemp Immersion Heating, Signode benefits in many ways. Unlike underfired pots, Kemp pots are *not* subject to *periodic* and expensive shutdowns . . . won't crack or break. They operate *continuously* at maximum heating efficiency with a ***substantial*** savings in fuel costs. Offer a greater heating surface, faster heat recovery, lower dross formation, even lower room temperatures. At the same time, this Kemp unit enables Signode to eliminate costly temperature override and open flame fire hazards.

Let Kemp Solve Your Problems

These same advantages apply to all types of melting or heating operations. Whether you are engaged in tempering, annealing, descaling, coating, etc., you can rely on Kemp Immersion Heating. Why not find out how Kemp Engineers can help you, save you money?



This 10 ton oval pot is typical of the many Kemp installations now in use. Features Kemp Carburetor, part of all Kemp equipment, to deliver complete combustion . . . without waste . . . without tinkering. One-pipe air and fuel feed reduces installation costs, simplifies maintenance.

For more complete facts and technical information, write for Bulletin IE 11 to C. M. KEMP MFG. CO., 405 East Oliver St., Baltimore 2, Maryland.

KEMP OF BALTIMORE



IMMERSION MELTING POTS

CARBURETORS • BURNERS • FIRE CHECKS
ATMOSPHERE & INERT GAS GENERATORS
ADSORPTIVE DRYERS • SINGEING EQUIPMENT

how durability of ARMASTEEL® PISTON applications in



In thousands of applications—in millions and millions of hours of operation—Detroit Diesel engines with ArmaSteel pistons have proved repeatedly their ability to stand up under any task.

In the original design of the Series 71 Detroit Diesel engine in 1937, much thought was given to the piston material. Aluminum pistons were susceptible to burning out. Gray iron, even the high alloy types, did not have sufficient strength or endurance for diesel service. Finally after exhaustive tests Central Foundry's pearlitic malleable iron—ArmaSteel—was found to be the ideal material. It did not burn out and it had exceptional endurance.

Through the years the horsepower of the Series 71 periodically increased until today it has twice the power of the original engine and this without increasing the size of the engine or the number of cylinders. And ArmaSteel Pistons in spite of the higher operating loads and extreme temperatures, are still performing flawlessly. As a result, ArmaSteel pistons are now standard in all Detroit Diesel engines.

As in these dependable Detroit Diesel engines, your product may be improved by the advantages of ArmaSteel's unmatched qualities of machinability, uniformity, high yield strength, excellent bearing properties . . . and the other remarkable characteristics of this pearlitic malleable iron.



This Diesel piston is cast and machined from grade 86 M ArmaSteel which provides a fine combination of high strength and machinability. Tensile strength is 70,000 psi. (double that of grade A cast iron). Yield is 48,000 psi. Because of ArmaSteel's structure the machinability rating is 95% that of S.A.E. 1112!





Heavy-duty scrapers (above, right) like this can scoop up and evenly distribute 20 cu. yds. at one sweep. They are dependably powered by Detroit Diesel engines with sturdy ArmaSteel pistons.

Always impressive workers, diesel shovels and trucks such as these (above) provide further proof of ArmaSteel pistons' great strength and long fatigue life.



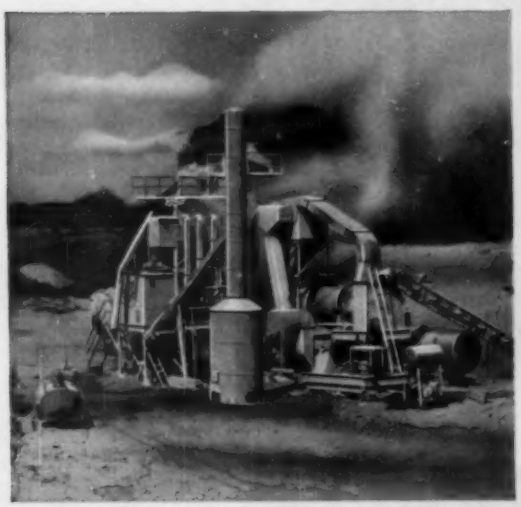
Seagoing tugs (right) with Detroit Diesel engines give ArmaSteel pistons a chance to prove their amazing fatigue life, since this application calls for an engine which is built to provide long hours of steady, unremitting service.

is proven in tough DETROIT DIESEL Engines

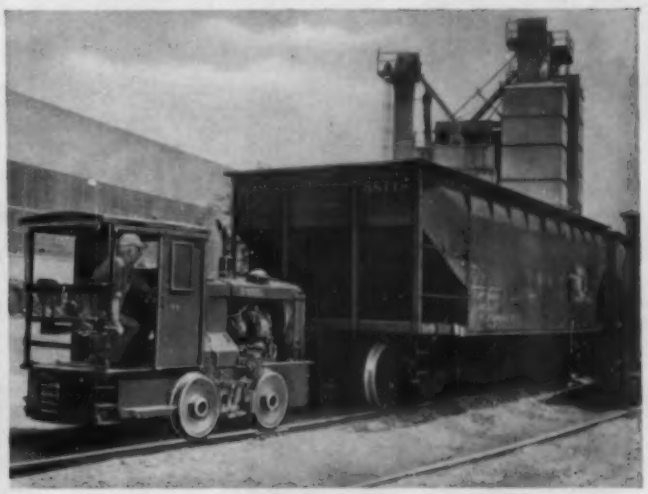




Fleet, smooth-powered giants of city streets and highways, these heavy busses subject their Detroit Diesel engines to violent speed changes, rapid load variations. In these applications, the ArmaSteel pistons prove that they are practically impossible to wear out (records show many busses run from 300,000 miles up to 550,000 miles without engine overhaul).



At this portable asphalt plant, where inaccessibility to utility power lines makes diesel power mandatory, a single generator, driven by a twin-6 GM Detroit Diesel engine furnishes power for 10 electric motors.



Dubbed "the Mighty Midget", this 8-ton yard locomotive—scarcely larger than a handcar—moves as many as 12 cars at once. The 3 ArmaSteel pistons in its power plant help it maintain its amazing power thru long hours of service.



ArmaSteel: a triumph of modern metallurgy, is repeatedly proving that it is far from reaching the limits of its versatility. These 2 free books, "ArmaSteel" and "Shell-castings", will help you discover how Central Foundry can serve you. Write for your copies.

CENTRAL FOUNDRY DIVISION

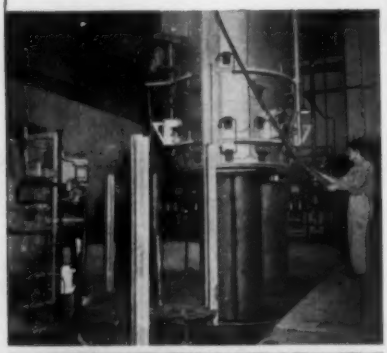
GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN. • DEPT. 19

Bright Annealing?
Normalizing?
Nitriding?
Spheroidizing?

You can't beat

CONTINENTAL TOP HAT





COVER-TYPE ANNEALER

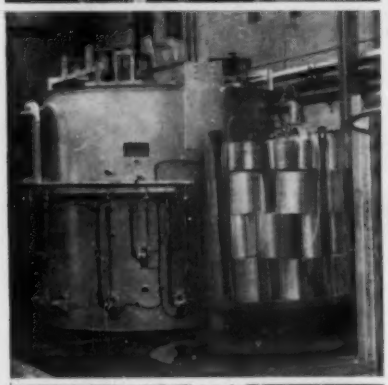
Faster and More Uniform Heating Rate

Extra large volume of recirculating atmosphere.

Highest Production per Unit

Versatility

Can be used for bright annealing, normalizing, nitriding, or spheroidizing coiled wire or strip—ferrous or nonferrous.



High Efficiency

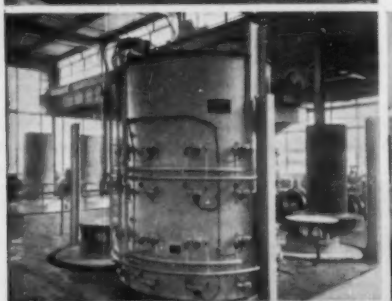
No radiant tubes.

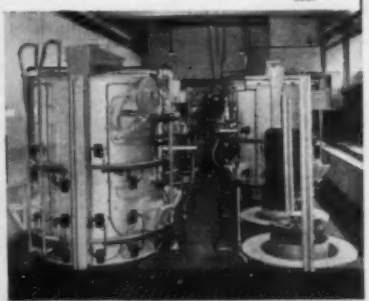
Long Hood Life

No flame impingement.

Full particulars and recommendation for any job on request.

6367





Over One-Third of a Century of Progress in
FURNACES · PRODUCTION LINES · SPECIAL MACHINES · COMPLETE PLANTS

CONTINENTAL INDUSTRIAL ENGINEERS, INC.
176 West Adams Street, Chicago 3, Illinois

Personals . . .

James A. Kearney has been named to the newly created position of group leader in the development group of the Crucible Steel Co. of America, Pittsburgh. Mr. Kearney's primary responsibility will be coordination of the activities of personnel from various sections of the company in the study of problems concerning general corporate development. Joining Crucible in 1930, he last held the position of chief metallurgist.

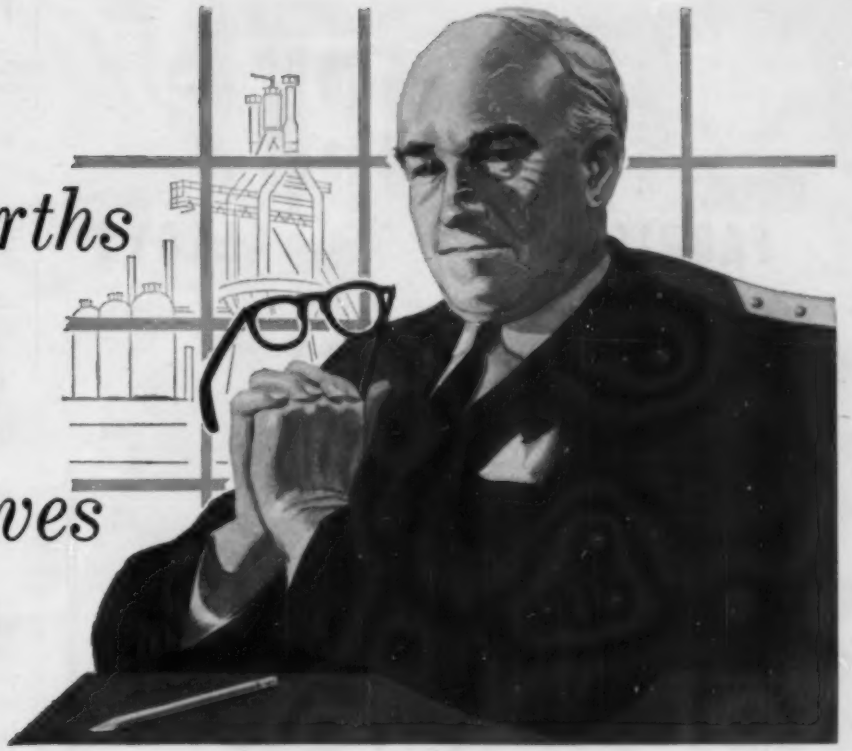
David K. Priest has assumed additional duties as administrator to the ceramic development group and the physical testing laboratory for the Pfaudler Co., Rochester, N.Y. Dr. Priest, who joined the company in 1953 as a research engineer in metallurgy, is also head of the corrosion laboratory.

Marshall Sittig, formerly manager of technical advertising for Ethyl Corp., is now president and managing director of the American Lithium Institute, Inc., Princeton, N.J. In this capacity, he is directing the Institute's programs of research on industry-wide problems, and dissemination of technical information on lithium and its compounds. The Institute was established by the three major lithium producers in this country, American Potash and Chemical Corp., Foote Mineral Co. and Lithium Corp. of America, to conduct research and to act as an agency for the correlation and dissemination of technical data. The Institute has initiated a program of sponsored research at Massachusetts Institute of Technology and Pennsylvania State University and in addition has established fellowships at these two institutions.

Olev Paul is now a physical metallurgist with the general engineering laboratory of General Electric Co., Schenectady, N.Y.

Harold Hessing has rejoined the chemical metallurgy section of the National Bureau of Standards, after five years developing materials for high temperature and missile uses for the Navy Dept. and the General Electric Co. Mr. Hessing originally was a member of the staff of the Bureau's metallurgy division from 1940 to 1952.

Rare Earths and Steel Executives ?



- Interested in producing low-carbon steels
- Decreasing production man-hours
- Increasing shippable yields

Man-hours of production cost and shippable yields now afford the steel producer just about the only opportunity for improvement to meet price and quality competition.

The addition of but small quantities of MCA rare earth materials frequently results in valuable savings in surface preparation costs and increased shippable yields, both of which have been demonstrated in production runs. Plate steels, deep-drawing sheet steels, low-carbon steels, silicon and stainless steels, and steels demanding transverse properties are among those especially susceptible to improvement with rare earths.

The substantiated proof of rare earths in steel-making economy and MCA's technical knowledge are unsurpassed. Write or call today for details.

MOLYBDENUM CORPORATION OF AMERICA

Grant Building Pittsburgh 19, Pa.

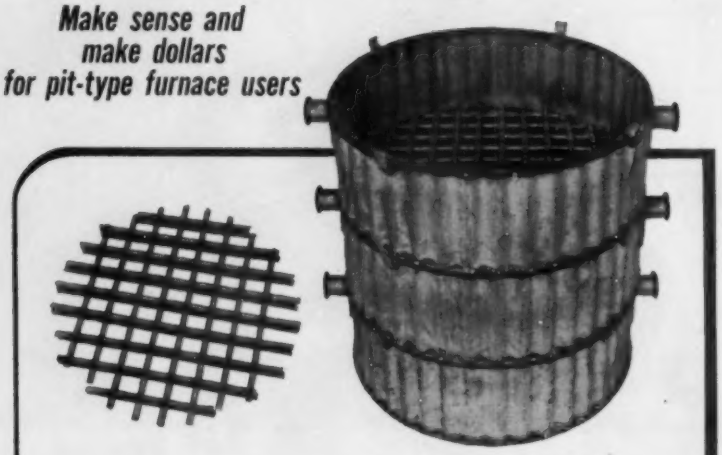
Offices: Pittsburgh, Chicago, Los Angeles, New York, San Francisco
Sales Representatives: Brumley-Donaldson Co., Los Angeles, San Francisco
Subsidiary: Cleveland Tungsten, Inc., Cleveland
Plants: Washington, Pa., York, Pa.

MCA

ROLOCK

FABRICATED HEAT AND CORROSION RESISTANT ALLOYS

Make sense and make dollars for pit-type furnace users



ROLOCK'S unique CORRUGATED construction

with pressure-welded truss-type grids

There are many good reasons why these new furnace baskets out-perform and outlast older types. ROLOCK's Corrugated Construction gives high strength with light weight and this, in turn, means less material to bring up to temperature with faster, more uniform heat transfer . . . and a higher ratio of pay load to basket weight. Such baskets mean a substantial saving in furnace time because of faster recovery and, in some cases, an increase in average load as well.

ROLOCK's specialized Welded Fabrication takes full advantage of this construction in every respect. The grid, for example, is built up from rounds rather than flats by a ROLOCK-developed pressure-welding method. Experience shows that such grids are far better able to withstand thermal shock. They may be reversed as required, to compensate for deflection, without cracking.

In this field, as in many other specialized applications of welded-fabricated heat-resistant alloys, ROLOCK's exceptional facilities and skills often promise major operating savings. Write us outlining your problems.

SALES & SERVICE FROM COAST TO COAST

ROLOCK INC., 1222 KINGS HIGHWAY, FAIRFIELD, CONNECTICUT

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

6RL57

Personals . . .

Arthur A. Miller is now doing research engineering on titanium for Boeing Airplane Co., Seattle, Wash. Before coming to Boeing, Mr. Miller was employed at the Micro Switch Div. of Minneapolis - Honeywell Regulator Co., Freeport, Ill., where he was engaged in research engineering work on mercury.

Lenox Rand is now a commodity-industry analyst with the U.S. Bureau of Mines, Pittsburgh. He was formerly associated with Paine, Webber, Kackson & Curtis, Columbus, Ohio.

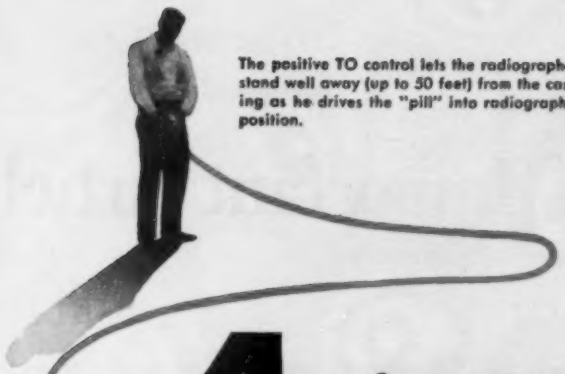
Wallace E. Carroll, president of American Gage & Machine Co., Chicago, received an honorary degree of doctor of laws from Boston College at the school's June commencement. A Boston College alumnus, Mr. Carroll is at present on loan from his business activities to serve for six months as director of the metalworking equipment division, Business & Defense Services Administration, Washington, D.C.

R. D. Leslie, a sales service engineer at the St. Louis branch of the Crucible Steel Co. of America, Pittsburgh, has been promoted to assistant branch manager. Mr. Leslie, who joined Crucible in 1946 as a sales trainee at the Sanderson-Halcomb works in Syracuse, N.Y., has held sales positions at the Chicago and Indianapolis branches before coming to St. Louis.

Robert W. Murphy, vice-president and general counsel for Borg-Warner Corp., Chicago, has been elected chairman of the executive committee of the company. Affiliated with Borg-Warner since 1937, he became general counsel in 1948, and five years later assumed additional responsibility as a vice-president.

Charles E. Smith has taken a post as assistant national service director of Robertshaw-Fulton Co., with headquarters in Youngwood, Pa. Before coming to the company, he was manager of the product service division of A. O. Smith Corp., Kankakee, Ill.

Clarence T. Patterson has retired from Solvay Process Div. of Allied Chemical & Dye Corp., Syracuse, N.Y.



The positive TO control lets the radiographer stand well away (up to 50 feet) from the casting as he drives the "pill" into radiographic position.

4 minutes *does it*

The man up there radiographing that 2″ thick steel casting down there will have the job done in four minutes.

That's how fast modern gamma radiography is.



He's doing the job with 50 curies of Iridium 192 carried in this TO412A mobile radiography unit.

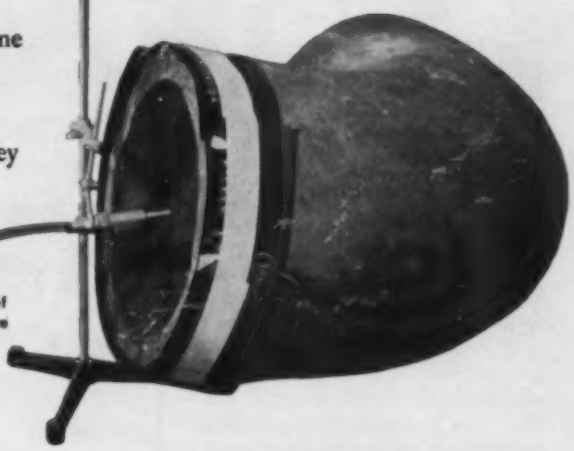
The isotope he's using (Iridium 192) will give him 2% sensitivity, too. Matter of fact, you can easily get 2% sensitivity in sections up to 6″ of steel, brass, copper, bronze . . . even *lead* . . . when you match the isotope to the job.

Makes no difference what you *make* or *buy* or *sell* (plastics, light metals, fabricated parts, assemblies—the list is endless) if it needs radiographic "seeing into" for quality control, we have the machine (gamma or x-ray) to do it most efficiently.

If *you are* confronted by an inspection problem why not let our consulting radiographers see what they can do for you? It will cost you nothing, may save you a lot. Call your local Picker* representative or write us outlining the situation.

Picker x-ray

25 South Broadway, White Plains, N. Y.



One "shot" radiographs the entire girth of the casting. Picker Flexible Film Holders are quickly taped on, quickly removed.

**There's probably a Picker district office near you (see your local 'phone book).*

PICKER . . . one stop for everything in industrial fluoroscopy and radiography

ANDREX lightweight portable x-ray units—130 KV, 160 KV, 200 KV, 260 KV and *Andrescope* X-ray Stress Analyzer.

PICKER x-ray units—5 to 50 KV, 150 KV (stationary and mobile), 270 KV portable, 260 KV heavy-duty, x-ray diffraction apparatus, rayproof inspection cabinets.

ACCESSORIES . . . films, tanks, darkroom sundries, illuminators, everything.

TECHNICAL OPERATIONS units for isotope radiography—sources, equipment, containers for Iridium ^{192} Cesium ^{137} Cobalt ^{60} and Thulium ^{170}.



Digests of Important Articles

Oxygen Cutting of Titanium

Digest of "Oxygen Cutting Titanium and Titanium Alloys", by G. Coates, *Engineer*, Vol. 203, Jan. 25, 1957, p. 132-134.

Compared to mild steel, titanium has a lower thermal conductivity but a higher melting point and a much greater affinity for oxygen. In flame cutting, the heat formed by combustion with oxygen is greatly in excess of the losses by conduction through the sides of the cut, and consequently titanium cuts with great rapidity – at least five times faster than steel – after being ignited at about 2000° F. The limiting speed has not yet been determined since the carriages of existing flame-cutting heads do not move fast enough. Satisfactory cuts can be made in titanium with equipment designed for work in mild steel, but almost certainly greater economy could be achieved by producing new designs or modifications.

Thin sheets can be stacked together and cut simultaneously without tight clamping. As the mass of kerf metal removed will, however, increase with the depth of the stack, the economy of such a process might be limited. A bar 9 in. in diameter can be cut through in a few minutes by a jet from a nozzle moved straight across on a line ¼ in. above the bar. The cut is conveniently started at a hot globule deposited on the titanium from the fused end of a steel welding rod.

Near an oxygen cut, titanium is hardened and cracked by structural changes or by absorption of oxygen and nitrogen. The depth of this hardened and cracked zone is about 0.05 to 0.10 in. with stock from 1/16 to 3 in. thick. Titanium burns so rapidly in an oxygen cut and generates so much heat that alloying elements used in structural titanium have no noticeable effect on oxygen cutting.

A cost comparison, based on English values, between sawing plus clean-up machining, and flame cutting plus machining to remove contaminated metal, is presented in the table. It shows a slight advantage for the latter with flat stock ½ or 1 in. thick and with round bars or billets 1¼ in. in diameter. Thicker stock could be cut more cheaply by sawing. Time was saved in every instance by flame cutting. In the cost estimates the loss in value between the titanium metal stock used (£5 Sterling per lb. weight) and the chips produced (£1 Sterling per lb.), or the total loss of stock burned, was taken into account as well as the time consumed. Machining times were estimated at 0.3 in. per min. across the thickness or diameter, sawing times at 0.72 in. per min., and flame cutting times at 24 in. per min. Interest and depreciation of machinery were allowed for, but not power, oxygen, or machine cutting tools.

It is the author's opinion that flame cutting would probably be most useful for titanium in cropping billets, trimming of thick semi-finished sections, preparation for welding, and cutting up scrap. Rotation of cylindrical billets while cutting should decrease the metal loss. In preparing sections for welding, merely grinding off the slag produced by the burning might be

Cost Comparisons for Titanium Cutting

Material	Thickness or Diameter	Cost* (Saw or Flame)	Cost (Machine)	Cost of Ti Losses	Total Cost†
Sawing and Machining					
Flat bar (per 12 in.)	⅛ in.	1·0 s.	0·2 s.	1·6 s.	2·8 s.
	½	4·0	0·8	10·4	15·2
	1	8·0	1·7	39·2	48·9
	2	16·0	3·3	78·4	97·7
	3	24·0	5·0	117·6	146·6
Round bar or billet	1	2·0	1·8	2·6	6·4
	1¼	2·5	2·2	4·0	8·7
	2	3·8	3·3	10·4	17·5
	4	18·8	6·7	39·2	64·7
	9	60·0	15·0	208·0	283·0
Flame Cutting and Machining					
Flat bar (per 12 in.)	⅛	0·1	0·4	2·9	3·4
	½	0·1	1·7	12	13·8
	1	0·1	3·3	39	42·4
	2	0·1	6·7	102	108·8
	3	0·1	10·0	186	196·1
Round bar or billet	1	0·0	3·3	2·6	5·9
	1¼	0·0	4·2	4	8·2
	2	0·0	6·7	13	19·7
	4	0·0	13·4	82	95·4
	9	0·1	30·0	690	720·1

*Costs are in shillings.
†Sawing or flame cutting plus clean-up machining plus titanium losses.



VANCORAM SILICOMANGANESE

Furnace block, desulphurizer and deoxidizer, all in one—that's Vancoram Silicomanganese. It's also an efficient and economical way to add manganese and silicon. Three types to meet all requirements—1.5%, 2% and 3% carbon grades, all with 65/68% manganese. Also available in square-shaped briquettes containing 2-lb. manganese, ½-lb. silicon. Call your nearest Vanadian Corporation Office for more information about Vancoram Silicomanganese and its many specific uses in steel and iron.

VANCORAM

VANADIUM CORPORATION OF AMERICA

420 Lexington Avenue, New York 17, N. Y.

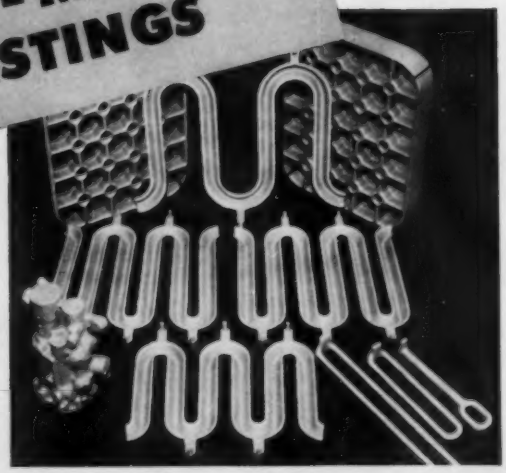
Chicago • Cleveland • Detroit • Pittsburgh

Producers of alloys, metals and chemicals

Announcing

a significant broadening of
Duraloy High Alloy Casting Service...

SHELL-MOLDED CASTINGS



DURALOY

We are now in position to accept and process substantial orders for shell-molded castings in the Chrome Iron, Chrome Nickel class.

Shell-molded castings provide several values over conventional castings:

a . . . dimensions are exceptionally accurate
b . . . thinner walls are practicable
c . . . surface finish is superior

Shell-molding is ideal for mass or repetitive production of parts particularly those with intricate design.

With our conventional static and centrifugal casting service now broadened by our shell-molded casting service, we are in a better position than ever to serve industry in connection with its high alloy casting requirements. May we quote on your casting requirements that call for shell-molding?



The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

Cutting Titanium . . .

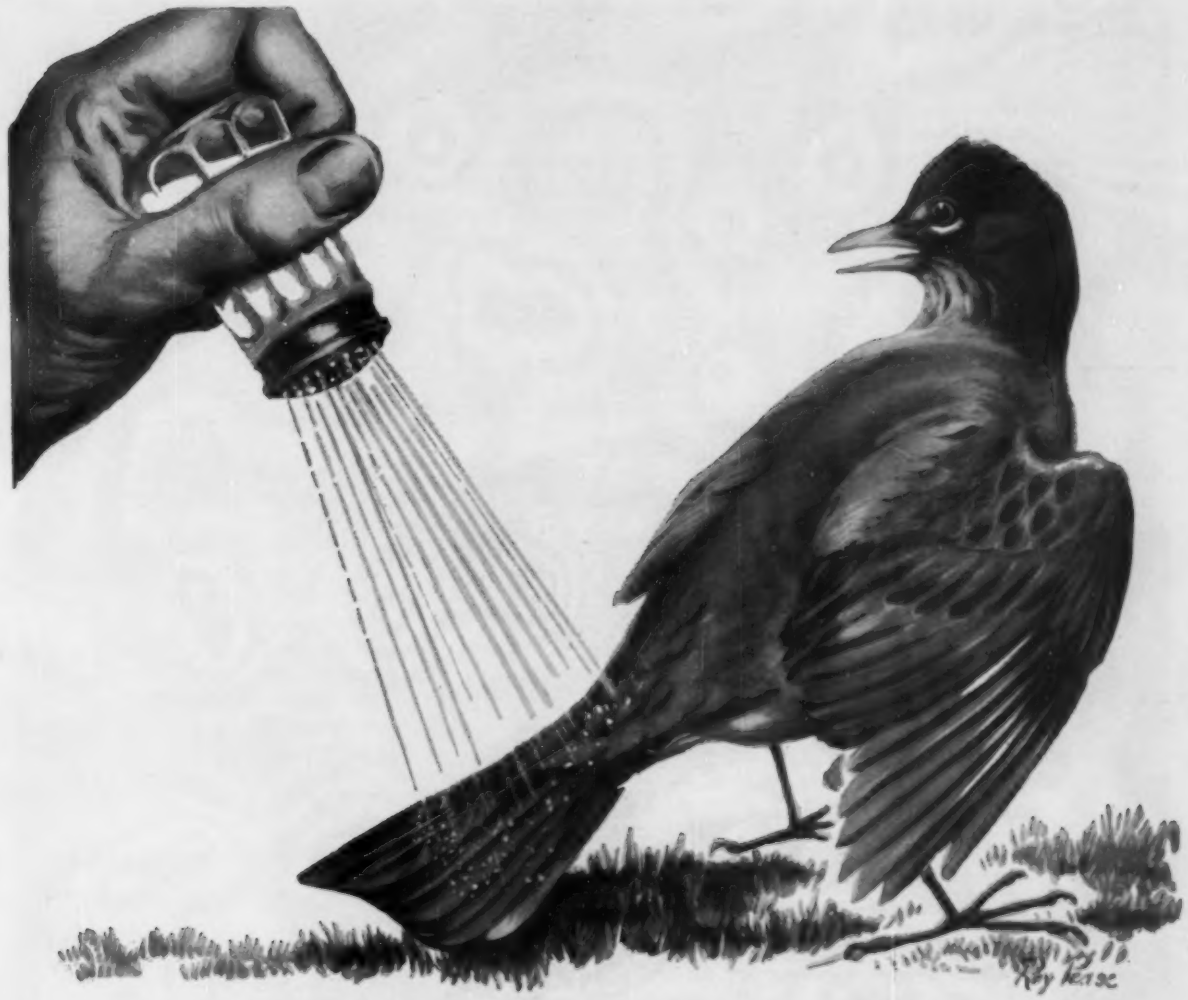
sufficient to minimize subsequent contamination of the weld metal by oxygen within acceptable limits. Flame cutting of scrap titanium should be of more interest in the future than now, since there is not yet a large market for scrap, and in view of the much easier application of flame cutting to titanium in comparison with the difficulties encountered in flame cutting steels of similar corrosion resistance.

D. F. RITCHIE

Creep-Resisting Steels for Steam Power Plants

Digest of "Creep Resisting Steels — Study of 7 and 8% Cr Types for Steam Power Plants," by M. G. Gemmill, H. Hughes, J. D. Murray, F. B. Pickering and K. W. Andrews, *Iron & Steel*, Vol. 29, Dec. 8, 1956, p. 614-623.

IN ORDER to obtain the same scaling resistance at 1150° F. as shown by a 1% Cr-Mo steel at 1050° F., the amount of chromium present must be about 7 or 8%. One drawback is that the creep resistance of steels containing only 7 or 8% chromium without any other alloying elements is inherently low. Preliminary work showed that the addition of molybdenum and aluminum was promising because of a carbide precipitation occurring in the ferritic matrix at the highest service temperature. A cast of steel containing 7% Cr, 3% Mo and ¾% Al was then made and the constitution of the steel determined in the temperature range 1740 to 2280° F. Various solution and tempering treatments were given and the resulting mechanical properties confirmed again that a precipitation hardening, fully ferritic steel was desirable. Aluminum was replaced by titanium because of the latter's stronger ferrite-forming tendency. Thirty-nine steels were then cast containing 7.48 to 14.28% Cr, 1.02 to 3.06% Mo and 0.39 to 3.17 Ti. The many constituents formed in these steels are as follows: titanium carbide between 2100 and 1020° F.; titanium nitride at all temperatures; the "Y phase" believed to be a second nitride of titanium; a Laves phase, the intermetallic compound



An old bromide about chlorides!

The old bromide that a salted tail immobilizes a bird has frustrated children for generations. Another old bromide that chlorides are ruinous to engineering metals has plagued design engineers for decades. That was before titanium.

Strong ferric, stannic and mercuric chloride solutions have no effect on titanium. Extraordinary resistance to mineral acids is shown by excellent performance in boiling 65% nitric acid.

Boiling glacial acetic, concentrated lactic and concentrated formic acids are completely resisted by titanium. Even vapors are non-corrosive.

Titanium is more than a "promising" metal for the chemical-processing and pulp industries. It's already paying for itself in applications where severe corrosion once posed forbidding maintenance or design problems. Titanium means longer service life, less down-time.

All forms of titanium—tubing, sheet, wire, strip, plate, extrusions, bar and billet—are routine production items for TMCA, at prices attractively competitive with other engineering metals. Extensive research facilities and trained technical service personnel are available to provide quick answers to specific requests.

. . . FIRST IN Titanium . . . . . .

TITANIUM METALS CORPORATION OF AMERICA, 233 Broadway, New York 7, N.Y.

Creep Resisting Steel . . .

Fe_2Ti precipitated between 1380 and 1740° F.; and finally the carbide $M_{23}C_6$, a (Cr,Fe,Mo) carbide. The precipitation of this last carbide caused the greatest increase in hardness of the steel.

The effect of the rate of cooling and isothermal heating on precipitation behavior and the effect of prior structure on creep properties were investigated on one of the steels. It was found that Fe_2Ti forms on continuous cooling while $M_{23}C_6$ does not. The latter phase, however, was found beneficial to creep properties when produced in the structure by a solution and precipitation treatment at 1020° F., that is, at a temperature lower than the service or testing temperature. The considerable increase in hardness caused by the precipitation of $M_{23}C_6$ is ascribed to coherency hardening rather than to dispersion hardening.

The three other compounds, TiC, TiN and the "Y phase", are present in all specimens but play only a minor role on the properties of the material.

The effects of the addition of small quantities of columbium, tungsten and vanadium on solubility limits was found negligible in most tests. Columbium, however, has an effect on the solubility of the Laves phase.

All the steels were then submitted to testing conditions related to prospective industrial applications. These conditions included creep-rupture tests at 1155° F. under a stress of 24,640 psi. and scaling resistance tests at 1050, 1110 and 1165° F. in flue-gas and steam atmospheres. The steels were in the air cooled condition after a solution treatment at 1920° F.

The best results were obtained with steels of base composition 7 to 8% chromium and 3% molybdenum with variable titanium and carbon contents. Titanium had a beneficial effect on the rupture strength while carbon had a detrimental influence probably due to its effect in removing titanium in solid solution in the ferrite. The resistance to scaling was better in the 8% chromium steels and further work was carried out on new heats of steels containing 8% Cr, 3% Mo, and no more than 0.1% C with 1 to 1½% Ti.

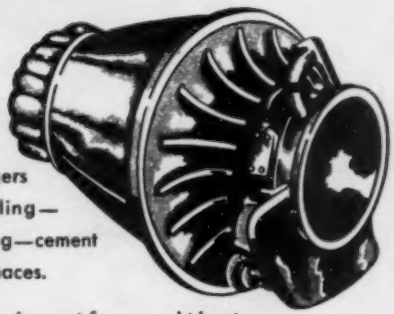
Physical and mechanical properties of these steels were determined and cold drawing and weldability trials carried out.

The thermal expansion of the new steel is 10% lower than that of the conventional ferritic 2¼% Cr-Mo steel. Consequently, stresses at austenitic-ferritic junctions are reduced by the use of this intermediate steel in lieu of the austenitic material. The mechanical properties are higher than those of the conventional steel at 930, 1110 and 1200° F. The rupture tests revealed a good level of rupture ductility and the strength is fairly high but the room-temperature impact is low. While it has been possible, nevertheless, to carry out severe fabrication at room temperature, it is suggested that the material be worked hot to take advantage of its high ductility at elevated temperatures.

H. P. TARDIF

WROUGHT HEAT RESISTANT ALLOYS
Vital for the Jet Age





Combustion chambers for jet engines—fixtures to braze honeycombs or heat treat gears—hangers for porcelain enameling—molds for glass forming—cement kilns or refinery furnaces.

Whatever your requirement for wrought heat resisting alloy—new as a space ship or old as the automobile—Rolled Alloys can serve you best.

Experienced high temperature metals engineers in all major industrial areas to assist with your problems.

Whether you need a few pounds for maintenance or several tons for production, when you need wrought heat resisting alloy RA is your dependable storeroom.

More than 500 items, over 1½ million pounds, in all mill forms in stock for immediate shipment.

Two strategically located warehouses to expedite delivery.

Send for Literature and Stock List

ROLLED ALLOYS, INC. RA
Heat and Corrosion Resistant Alloy Specialists

4815 Bellevue Ave., Detroit 7, Mich. • Williams St., South River, New Jersey

A meeting of minds and talents...
brings zirconium in quantity and quality
...from Columbia-National



No ingredient is more important, as zirconium comes of age, than the experience and technology that goes into producing the metal.

Columbia-National, jointly owned by Columbia-Southern Chemical Corporation and National Research Corporation, is a source supported by a unique combination of abilities. Columbia-Southern is one of the country's important manufacturers of chlorine and alkalies, with long experience in producing and delivering on schedule. National Research represents the nation's most advanced knowledge in extractive metallurgy, vacuum technology and the production of high-purity rare metals.

Columbia-National's Florida plant has a design capacity of 1.5 million pounds, of which over one-third will be available to industrial customers.

For that extra margin of dependability — specify Columbia-National zirconium, supplied in the sponge form, preferred for consumable electrode arc-melting. C-N offers the latest information on melting and application techniques. Write for technical data on zirconium and its properties.

NEW METALS FOR INDUSTRY

Columbia-National Corporation

Jointly owned by Columbia-Southern Chemical Corporation and National Research Corporation

DEPT. R-2C — 70 MEMORIAL DRIVE, CAMBRIDGE 42, MASS.

PERFORMANCE REPORT FROM KENNAMETAL*



If you have any sealing ring problem that demands . . .

1. **Extreme resistance to abrasion, or**
2. **The ability to resist elevated temperatures, or**
3. **Unusual resistance to severe corrosion.**

KENNAMETAL has some proven answers for you.

ABRASION RESISTANCE. Kennametal tungsten carbide sealing rings installed in a deep-well rotary pump gave one to two years' service; packing type seals had failed in two to four weeks. Kennametal rings in a recirculating pump, handling water with fine grains of iron oxide, lasted 30 to 60 *days*. Packing type seals failed in 24 to 48 *hours*.

ELEVATED TEMPERATURES. A jet engine shaft seal of Kentanium,* a titanium carbide, operating without lubrication at 15,000 surface feet per minute under 0.3 to 0.6 lbs. pressure per lineal inch of circumference and 900° to 1000° F, outperformed every other material. Kentanium Rings are stress-free—do not tend to split radially, maintain original face flatness even at high temperatures, and have exceptional wear and resistance strength.

SEVERE CORROSION. Where corrosion and abrasion are present, Kennametal has seal rings of Grade K501, a platinum-bonded carbide. Used as seals to confine liquid oxygen or fuming nitric acid, sealing results are reported as "far superior to any previously used materials, with no indication of face wear."

Other desirable characteristics of Kennametal seals: high modulus of elasticity, low expansion under heat, high resistance to wear and much lower service cost. For more information, ask for "Characteristics" book, write KENNAMETAL INC., Latrobe, Pennsylvania, Dept. DM.

*Kennametal and Kentanium are the trademarks of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum. C-5070

INDUSTRY AND
KENNAMETAL
. . . Partners in Progress

Weight Losses of Various Alloys in Titanium Tetrachloride

Digest of "The Corrosion Resistance of Constructional Materials to Titanium Tetrachloride", by F. L. Bett, *Journal*, Australian Institute of Metals, Vol. 1, May 1956, p. 49.

THE WEIGHT LOSSES of various alloys in titanium tetrachloride at the boiling point, (278° F.) and above (up to 932° F.) have recently been determined in tests of at least 2 hr. duration at the University of Melbourne in Australia. The alloys tested included stainless steels with and without molybdenum, nickel-base alloys, bronzes, plain and alloy steels, cast iron, molybdenum and aluminum.

In the test clean weighed specimens were suspended on a tungsten support inside a pyrex glass vessel which contained hydrogen while it was being heated. When the test temperature was reached titanium tetrachloride vapor replaced the hydrogen, and at the end of the exposure period hydrogen replaced the tetrachloride again before cooling rapidly.

At 278° F. all the stainless steels and nickel-base alloys, the molybdenum, plain mild steel, and cast iron did not lose any weight; free-cutting mild steel, medium-manganese steel, nitralloy, and aluminum bronze lost from 0.06 to 0.11 mg. per sq. cm. per hr.; phosphor bronze and manganese bronze lost 0.19 to 0.28, and aluminum lost 3.06 mg. per sq.cm. per hr.

Only molybdenum, the stainless steels, and nickel-base alloys were tested at higher temperatures. The only specimens that lost no weight at 752° F. were 18-8 stainless steels containing 5% molybdenum.

At 932° F. all the specimens acquired loose, hygroscopic, water-soluble surface films, and Inconel lost only 0.9 mg. per sq.cm. per hr. as determined after removal of the film. This compared with values of 7.4 to 9.4 for molybdenum, nickel, Monel, and 18-8 stainless steel with 5% molybdenum both welded and not welded; and with values from 20.7 to 43.3 for Nimonic 75 and stainless steels without molybdenum.

GEORGE F. COMSTOCK.

Metal Progress

Bulletin Board...

The Buyers Guide For Metals Engineers

ELECTRIC FURNACES

custom designed or standard models at practical prices



Dyna-Bar High Temperature Furnace



Dyna-Trol Furnace

- Temperature Range—Dynatrol to 2300° F. Dynabar to 2850° F.
- Dynatrol models—from $90.
- Zone temperature control.
- Pyrometer selector switch for zone temperature indication.
- Patented Element Holders for quick element changing, low heat input requirements and fast recovery time.
- Automatic hold and cutoff instruments at modest additional cost.
- Infinite variety of time-temperature curves.
- Doors—hinged or vertical sliding.
- Circulating fans available in Dynatrols—models to 1850° F.
- Rugged Construction
- 83 standard models
- Firing chamber sizes up to 40" x 36" x 72".

Need a special furnace or oven for glass or metal annealing, atmosphere work, extra high temperatures (to 3200°)? Tube or dr. wing furnaces, Moly-wound furnaces? We'll quote you promptly.

Write for Literature

Industrial Division

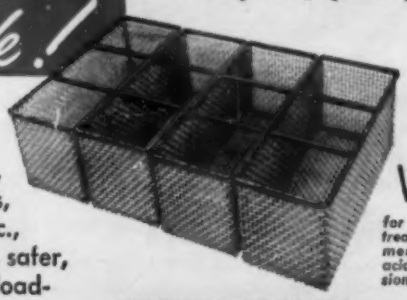
L and L Manufacturing Company

CHESTER 77, PENNSYLVANIA

LIST NO. 138 ON INFO-COUPON PAGE 169

Custom Made!

all styles, metals, weaves ...any size, quantity!



Wiretex engineers Baskets, Muffles, Screens, Fixtures, Grids, Racks, etc., to insure easier, safer, loading and unloading; greater space saving, better draining and cleaning.

Call Wiretex for all your heat treating requirements to resist acid, heat, abrasion or exposure.

Wiretex mfg. co.

5 Mason St., Bridgeport 5, Conn.

Specialists in Processing Carriers Since 1932.

LIST NO. 114 ON INFO-COUPON PAGE 169

GOOD USED EQUIPMENT AT REAL SAVINGS TO YOU!

In our large, rapidly turning-over stock, we often acquire brand-new items, still in their original crates. We offer these at a fraction of their replacement cost, and with the same guarantee that the original manufacturer gives. Several of our new furnaces are pictured below.



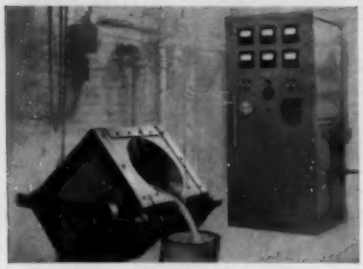
Upton Salt Bath
Hi and Low Heat
Price $19 75 Each

Our stock is constantly changing! Before you buy any furnace or accessory, call us collect and let us show you how to save money! (Money-Back Guarantee). We pledge that any unit we advertise is in stock at one of our warehouses at the original time of publication. However, they are subject to prior sale, so act now!

METAL TREATING EQUIPMENT EXCHANGE, INC.
9825 GREELEY ROAD
DETROIT 11, MICHIGAN

LIST NO. 142 ON INFO-COUPON PAGE 169

Inducto



THE INDUCTION MELTING FURNACE WITH PRECISION CONTROL

Here is induction metal melting equipment at its best!

NEW FURNACE DESIGN . . . Sturdy, welded construction eliminates distortion and increases lining life.

NEW COMPACT CONTROL . . . Totally enclosed panels include built-in capacitor bank, selector switches and high frequency transformer. Compact design for efficient operation and shipped completely assembled.

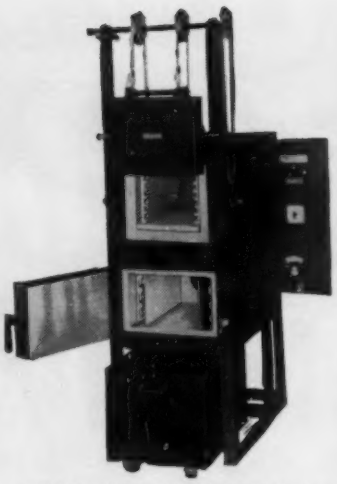
WATER COOLED LEADS . . . Introduced through trunnion. No furnace pits necessary. Shorter leads mean more operating efficiency.

SELECTOR SWITCHES . . . Can be mounted on lower front of control panel for maximum accessibility and minimum bus losses. You can change furnaces in a few seconds.

For details, write for our Bulletin 70.

INDUCTOTHERM CORPORATION
412 ILLINOIS AVE.

LIST NO. 144 ON INFO- COUPON PAGE 169



SAVE SPACE WITH A SERIES 8055 COMBINATION MODEL

Two independent furnaces (hardening and drawing) in the same floor space one requires. Complete with independent controls. Hardening furnace available in both a 2000° and a 2300° F. range.

Drawing furnace has a maximum of 800° F.* Quench tank included with the exception of the largest standard model.

	Chamber Size			Prices	
Model	H.	W.	L.	2000° F.	2300° F.
8055 A	6"	x 6"	x 12"	$ 865.00	$ 975.00
8055 B	9"	x 9"	x 18"	1325.00	1450.00
8055 C	12"	x 12"	x 24"	1850.00	1950.00
8055 D	18"	x 18"	x 36"	2750.00	2875.00

*Also available up to 1250° F.

WRITE FOR FREE LITERATURE, SPECIFICATIONS and price list of Lucifer Furnaces in wide range of sizes—top loading and side loading types. Engineering advice without obligation. Write, wire or phone today.

LUCIFER FURNACES, INC.

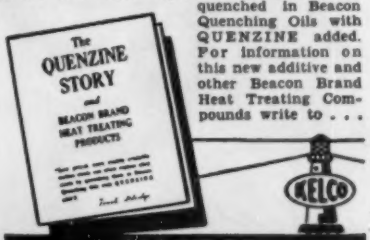
NESHAMINY 7, PA.
Phone Osborne 5-0411

LIST NO. 122 ON INFO-COUPON PAGE 169

FREE

the QUENZINE STORY

Low priced, more readily available carbon steels can often replace alloy steels when quenched in Beacon Quenching Oils with QUENZINE added. For information on this new additive and other Beacon Brand Heat Treating Compounds write to . . .



ALDRIDGE INDUSTRIAL OILS, Inc.

3401 W. 140th St., Cleveland 11, Ohio

LIST NO. 29 ON INFO-COUPON PAGE 169

Reserve NOVEMBER 2 to 8

to attend the

National Metal Congress and Exposition in CHICAGO

the mark of dependable HEAT TREATING EQUIPMENT

HEAT TREATING EQUIPMENT

Stanwood is one of the oldest organizations devoted to the design and manufacture of heat treating equipment exclusively for heat treaters and metal working plants throughout the nation.
Stanwood has the experience, the organization and the facilities.
Representatives in major cities. Send for Catalog.

STANWOOD CORPORATION

4817 W. CORTLAND STREET — CHICAGO 39, ILLINOIS



LIST NO. 12 ON INFO-COUPON PAGE 169



ROUND, SQUARE, FLAT AND HALF-ROUND WIRE FOR MASS PRODUCTION OF SMALL PARTS

Beryllium Copper • Bronzes
Other Non-ferrous Alloys
Rounded or square edges.
Available with hot-tinned finish for solderability.
Write for descriptive folder.

LFA LITTLE FALLS ALLOYS
INCORPORATED
193 Caldwell Ave., Paterson 1, N. J.

LIST NO. 66 ON INFO-COUPON PAGE 169

WRITE, WIRE or PHONE FOR YOUR CATALOG Today



Star Stainless screws have clean—bright—shiny—heads

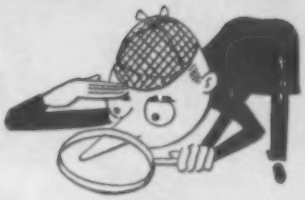
STAR STAINLESS SCREW CO.

CORROSION RESISTANT

647 Union Blvd., Paterson 2, N. J.
Telephone: Little Falls 4-2300
Direct N.Y. 'phone Wisconsin 7-9041

LIST NO. 99 ON INFO-COUPON PAGE 169

FREE
Listing Service for Used Equipment



Mr. Buyer—
LOOKING FOR USED EQUIPMENT?

This new service on used heat treating equipment is completely without obligation to you. To receive the latest availabilities just drop us a line requesting to be placed on our mailing list for a monthly digest. What are your production requirements?

Mr. Seller—
WITH EQUIPMENT TO SELL!



Take advantage of the opportunity to list useful, but no longer needed used heat treating equipment. Send us details including manufacturer, type, size, capacity, original and asking price. Monthly digest will be mailed to all listed firms.

ANOTHER HOLDEN SERVICE

This free listing is yours at no cost. CHECK WITH HOLDEN FIRST. Proven MONEY MAK-ER PRODUCTS.

THE A. F. HOLDEN COMPANY
MANUFACTURING PLANTS
DETROIT, MICH. (BRoadway 3-5405) LOS ANGELES, CALIF. (LUdlow 1-9153)
NEW HAVEN, CONN. (STate 7-5885)

LIST NO. 127 ON INFO-COUPON PAGE 169

Engineering Data on MOLYKOTE® lubricants



- Being published regularly
- Every issue features a full-length technical article on the use of MOLYKOTE Lubricants in industry.
- "How-to" stories on tough lubrication applications
- Get on our mailing list TODAY. Write to

The ALPHA MOLYKOTE CORPORATION
Main Factories:
[illegible] Harvard Avenue, Stamford, Conn.
[illegible] Munich 15, Germany

LIST NO. 110 ON INFO-COUPON PAGE 169

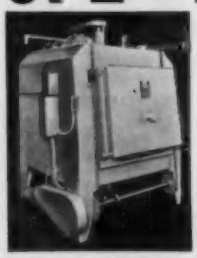
A CABLE SPLICED IN 10 SECONDS!



ERICO PRODUCTS, INC.
Complete Arc Welding Accessories
2070 E. 61st Place, Cleveland 3, Ohio
Write for Caddy Catalog

LIST NO. 71 ON INFO-COUPON PAGE 169

SFE RECIRCULATING FURNACES



• VERSATILE
All sizes to 1800° F.

• QUALITY
All work meets most rigid metallurgical specifications

• LOW OPERATING COST
Recirculation is the key—shorter cycles—excellent heat uniformity.

Write for complete information.

STANDARD FUEL ENGINEERING CO.
667 S. Post • Detroit 17, Mich.

LIST NO. 152 ON INFO-COUPON PAGE 169

Now...
HARD BRIGHT GOLD
with All the Attributes

In Technic HG Gold you will find *all* the attributes you have needed in hard bright gold:

TECHNIC HG GOLD QUALITIES

Bright smooth-grained deposits
Super hardness: 130-150 DPH
Low stress, less porosity than usual bright gold
High karat: 23+

TECHNIC HG GOLD ADVANTAGES

Wide operating range (60° to 95° F), no cooling or heating required
Low cyanide: less than 1/10 oz. per gal.
No organic brighteners
Low cost: less than 10¢ per troy oz. over regular 24 kt gold
High efficiency: requires less gold to meet most specifications

Only Technic HG Gold fills all your requirements . . . find out for yourself that it is everything a hard bright gold should be.

Send for Brochure: TECHNIC HG GOLD

TECHNIC, INC.
39 Snow Street,
Providence, R. I.
JAckson 1-4200
Chicago Office—7001
North Clark Street
THE LARGEST ENTERPRISE OF ITS KIND IN THE WORLD

LIST NO. 124 ON INFO-COUPON PAGE 169

JELLIFF BASKETS



for ALL Industrial Uses
- Degreasing
- Anodizing
- Pickling
- Plating
- Heat Treating
- Heavy Industrial Types

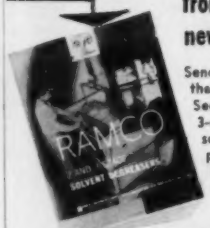
ANY SIZE AND SHAPE • ANY DUCTILE METAL
Ask for Bulletin 28

THE C. O. JELLIFF MANUFACTURING CORP.
SOUTHPORT • CONNECTICUT

LIST NO. 91 ON INFO-COUPON PAGE 169

Q A METAL PARTS CLEANING PROBLEMS?

Get the answers RIGHT from RAMCO'S new BULLETIN!



Send for your copy of the Ramco Bulletin. See how Ramco 2- and 3-dip degreasers can solve your metal parts cleaning problems safely, efficiently, economically! Send today!

RAMCO EQUIPMENT CORP.
DIV. OF RANDALL MFG. CO., INC.
809 Edgewater Rd., New York 39, N.Y.

LIST NO. 128 ON INFO-COUPON PAGE 169

Again this year!

NATIONAL METAL CONGRESS AND EXPOSITION

&

WORLD METALLURGICAL CONGRESS

Chicago
November 2 to 8

RUST-LICK IN AQUEOUS SYSTEMS

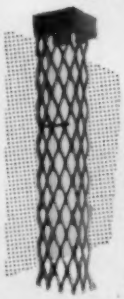
Grade "B"
FERROUS METAL PROCESSING
Eliminates . . .
Rust
Fire Hazards
Toxicity
Dermatitis
Degreasing

Write for free sample and brochure
Specify Grade "B"

PRODUCTION SPECIALTIES, INC.
755 BOYLSTON STREET
BOSTON 16, MASS.

LIST NO. 105 ON INFO-COUPON PAGE 169

there's a *Glo*-QUARTZ* IMMERSION HEATER for Your Every Heating Requirement



- INSTANT HEATING
- SHOCK-PROOF
- AVAILABLE IN ALL VOLTAGES —WATTAGES, ONE AND THREE PHASE

Available from your Electroplating Distributor

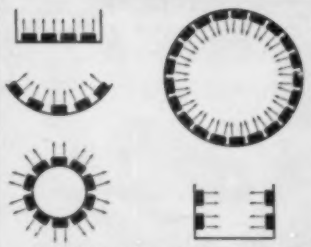
WRITE FOR BULLETIN ▶



Glo-QUARTZ
ELECTRIC HEATER CO., INC., Willoughby, Ohio
*Reg. U.S. Pat. Off. Phone: Willoughby 2-5521

LIST NO. 145 ON INFO-COUPON PAGE 169

ULTRASONIC CLEANING



Typical Transducer Arrangements

SONOGEN®

Ultrasonic-Power Generators with hermetically-sealed barium-titanate Transducers — 40Kc/sec.

Transducer Radiating Areas of ¼ sq. ft. to 10 sq. ft. — for use in solvents and detergents.

Eliminates hand operations — Reduces rejects in plating, finishing, assembly.

For washing, degreasing, removal of buffing compounds, radioactive contamination, soldering flux, plaster, carbon smut, etc.

Literature upon request.

BRANSON ULTRASONIC CORP.

Specializing in Ultrasonics Since 1946

[illegible] STAMFORD, CONNECTICUT

LIST NO. 81 ON INFO-COUPON PAGE 169

WELDCO FABRICATED MONEL PICKLING EQUIPMENT

- Hairpin Hooks • Sheet Crates
- Steam Jets • Chain
- Mechanical Bar, Tube and Coil Picklers

THE YOUNGSTOWN WELDING & ENGINEERING CO.

3721 OAKWOOD AVE. . . YOUNGSTOWN, OHIO

LIST NO. 94 ON INFO-COUPON PAGE 169

BLACKENING COPPER?

To get the finest black finish on copper and all its alloys, including Duronze, Everdur, high zinc brass, beryllium and silicon bronzes, take advantage of the features of:

Du-Lite

CU-PREP

- No acid pickle or bright dip.
- No dimensional changes or surface damage.
- No acid drag-in. Assures stabilized blackening bath throughout longer life — more economical.

Write for full details. Du-Lite Cu-Prep is made and guaranteed exclusively by the metal finishing specialists:

Du-Lite

DU-LITE CHEMICAL CORP.

MIDDLETOWN 5, CONN.

LIST NO. 103 ON INFO-COUPON PAGE 169

Meet the Sel-Rex Family of Industrial Precious Metals....

BRIGHT GOLD
Mirror-bright finish in any thickness directly from the bath.
Patented

SILVREX BRIGHT SILVER
Crystal-clear solution that produces mirror-bright deposits.
Patented

BRIGHT RHODIUM
Brilliant, fine-grained, non-tarnishing deposits.

PUR-A-SALTS
Restores contaminated cyanide plating baths to full, trouble-free operation.
Patented

SILVER SOL-U-SALT
Non-dusting — safest and easiest to use.

RHODEX
Only rhodium electroplating process that yields extra heavy compressively stressed deposits.
Patent Pending

Sel-Rex

SEL-REX CORPORATION

Nutley 10, New Jersey

[illegible] Chicago — Los Angeles

Complete installations and servicing on all precious metals processes.

LIST NO. 108 ON INFO-COUPON PAGE 169

How Roll Coater
Pre-Painted
METAL SAVED MONEY AND IMPROVED QUALITY ON
R-C-000 LICENSE PLATES

PROBLEM:

Stello Products Company, Logansport, Indiana, manufacturer of tags, license and "booster" plates, had the problem of excessive direct labor charges. In the previous expensive method of making these items, plates had to be stamped from bare metal—and then cleaned individually—and spray painted on both sides. This method did not give the uniform quality demanded—and Stello turned to Roll Coater for a solution.

SOLUTION:

Roll-coated metal was tested by Stello Products Company. *Pre-painted* and *baked* on both sides, this metal eliminated *entirely* the cleaning and spray painting operations—withstood rigorous stamping tests—and relieved painting facilities for other jobs. Says J. C. Cotner, president of Stello Products Company, "Roll Coater metal is now saving us approximately 50% in direct labor costs—and is giving us the desired uniform quality in our plate production. It really solves our problem."

SEND FOR FREE BROCHURE and SAMPLE TODAY!

Roll Coater
INCORPORATED
PENDLETON INDIANA

LIST NO. 155 ON INFO-COUPON PAGE 169

NEW pocket size thickness gauge
ELCOMETER



Measures Non-Magnetic Coatings with ± 5% ± .0001" Accuracy

ELCOMETER measures thickness of porcelain enamel, paints, platings, foils, glass, paper, plastics, and other non-magnetic coatings quickly and accurately. Gauges flat or curved surfaces and hard-to-get-at spots easily. Needle locking device assures correct reading every time. Complete with tough leather case containing inner pocket for test strips. Weighs only 6 oz. Completely self-contained. Retail price: $68.00 F. O. B. Cleveland.

WRITE FOR ILLUSTRATED FOLDER

FERRO
FERRO CORPORATION
4150 East 56th Street
Cleveland 5, Ohio

LIST NO. 148 ON INFO-COUPON PAGE 169

SWIFT-KOTE
RUST PREVENTATIVES
OIL-KOTE—*solvent type*
SOL-U-KOTE
—water emulsified types
SEND FOR Data Sheets on metal cleaning, heat treating, blackening and plating.

JOHN Swift
CHEMICAL COMPANY, INC.
Canton, Connecticut

LIST NO. 92 ON INFO-COUPON PAGE 169

A New ASM Book
FATIGUE DURABILITY OF CARBURIZED STEEL

By

7 members of the General Motors Corp. Research Staff

It Discusses

Effect of Surface Condition on the Fatigue Resistance of Hardened Steel

Residual Stresses in Carburized Steels

Fatigue Durability of Carburized Steels

123 pages.....$4.00

American Society for Metals
7301 Euclid Ave.
Cleveland 3, Ohio

ORIGINATORS OF DI-PHASE METAL CLEANING
Solventol



DESIGNERS & BUILDERS OF SPECIALIZED METAL CLEANING EQUIPMENT
For Latest Information Write to:
SOLVENTOL CHEMICAL PRODUCTS, INC. • DETROIT 3, MICHIGAN

LIST NO. 13 ON INFO-COUPON PAGE 169

TENSILKUT

Patent Pending



Accurate test specimens machined from sheet and plate materials .0005 to .500 in., in less than 3 min.

SIEBURG INDUSTRIES, INC.

Horse Plain Rd. • New Britain, Conn.

LIST NO. 131 ON INFO-COUPON PAGE 169

WHITELIGHT

MAGNESIUM

your comprehensive independent mill source of magnesium alloy Tubes • Rods • Shapes • Bars Hollow Extrusions • Plate • Sheet • Pipe • Wire • Welded and Riveted structures and assemblies

WHITELIGHT MAGNESIUM

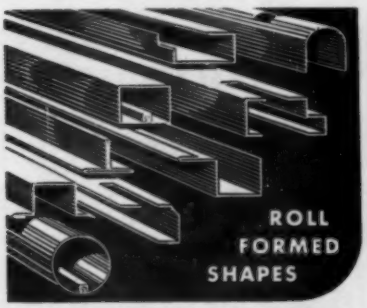
WHITE METAL ROLLING & STAMPING CORP.

82 Moultrie St., Brooklyn 22, N. Y.

Sales Office

376 Lafayette St., New York 3, N. Y.

LIST NO. 67 ON INFO-COUPON PAGE 169



Reduce your assembly problems and costs. Our shapes continuously formed, with high degree of accuracy, from ferrous or non-ferrous metals. Write for Catalog No. 1053.

ROLL FORMED PRODUCTS CO.

MAIN OFFICE AND PLANT

3761 OAKWOOD AVE. • YOUNGSTOWN, OHIO

LIST NO. 101 ON INFO-COUPON PAGE 169

---

the **GRIES**

MICRO-REFLEX HARDNESS TESTER

Loads: 10 to 3000 gram with CARL ZEISS Optical System

Measurements: to 0.0001 mm. . . . Observations on ground glass . . . Projection: to 0.001 mm. . . . many unique, very important features.



INVESTIGATE!

Write for Bulletin No. A-16

GRIES INDUSTRIES, INC.

Testing Machines Division

NEW ROCHELLE 3, N. Y.

LIST NO. 135 ON INFO-COUPON PAGE 169

MULTI MOTION DIES* . . . . FOR TEST SPECIMENS . . .



DL-1001
TENSILE TEST BAR
MPA STANDARD
10-51

- Tensile Bars
- Transverse Bars
- Green Strength
- Bushings
- Slugs
- Stepped Parts

Complete design facilities for dies or subpress units to press unusual shapes in lab presses.

*PATENTS PENDING

HALLER, INCORPORATED

684 W. Ann Arbor Rd., Plymouth, Mich.

LIST NO. 149 ON INFO-COUPON PAGE 169

STEEL FABRICATED and RUBBER-LINED TANKS for the Plating Industry



ARco

- Plating tanks any size or shape fabricated and rubber-lined to your specifications. A complete service from basic design to installation, also fabricated and rubber-lined pipe and fittings. Write Dept. "MP" for complete details.

Subsid of Automotive Rubber Co., Inc

ARco STEEL FABRICATORS • INC.

12542 BEECH ROAD • DETROIT 39, MICH.

LIST NO. 153 ON INFO-COUPON PAGE 169

Inspection Demagnetizing or Sorting PROBLEMS?

SOLVED with

MAGNETIC ANALYSIS MULTI-METHOD EQUIPMENT

Electronic Equipment for non-destructive production inspection of steel bars, wire rod, and tubing for mechanical faults, variations in composition and physical properties. Average inspection speed 120 ft. per minute.

Over 80 installations in steel mills and fabricating plants.

MAGNETIC ANALYSIS SPECIAL EQUIPMENT

Electronic Equipment for non-destructive production inspection of both non-magnetic stainless and high temperature steel bars and tubing—seamless or welded—as well as non-ferrous bars and tubing. Mechanical faults, variations in composition and physical properties are detected simultaneously. Average inspection speed 200 ft. per minute.

Over 30 installations in mills and fabricating plants.

MAGNETIC ANALYSIS COMPARATORS AND METAL TESTERS

Electronic Instruments for production sorting both ferrous and non-ferrous materials and parts for variation in composition, structure and thickness of sheet and plating.

MAGNETIC ANALYSIS DEMAGNETIZERS

Electrical Equipment for rapid and efficient demagnetizing of steel bars and tubing. When used with Magnetic Analysis Multi-Method Equipment, inspection and demagnetizing can be done in a single operation.

MAGNETIC ANALYSIS MAGNETISM DETECTORS

Inexpensive pocket meters for indicating residual magnetism in ferrous materials and parts.

TRADE MARK

For Details Write:

MAGNETIC ANALYSIS CORP.

42-44 Twelfth St., Long Island City 1, N. Y.

"THE TEST TELLS"

LIST NO. 51 ON INFO-COUPON PAGE 169

LOAD HEAT TREAT FURNACES *automatically*



Meters... Conveys... Elevates up to 5,000 lbs. per hour

Some of the largest metal working plants in America have proven that Man-O-Steel Furnace Loaders give fewer rejects, lower labor costs and increased production. Write today for bulletin.

MICHIGAN
Crane & Conveyor Corporation
119 M. McKinley Ave. • Detroit 9, Mich.

LIST NO. 156 ON INFO-COUPON PAGE 169

GET A BID FROM

HOOVER

SPECIALISTS IN THE FIELD OF

Die Castings

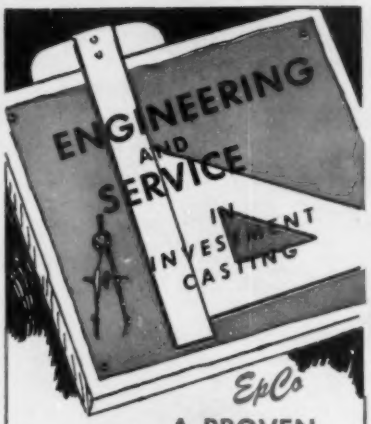
SINCE 1922

Aluminum and Zinc

HOOVER

THE HOOVER COMPANY
Die Castings Division
North Canton, Ohio
In Canada—Hamilton, Ontario

LIST NO. 74 ON INFO-COUPON PAGE 169



EpCo

A PROVEN DEPENDABLE SOURCE
FOR BETTER GRADE INVESTMENT CASTINGS IN FERROUS AND NON-FERROUS METALS



INVAR CASTING
Special Feature — Nickel content held to 35% minimum — 36% maximum

STAINLESS STEEL PART for milk bottling unit formerly machined from solid stock. Only finish operations required are reaming small dia. of counterbored hole and drilling and tapping for set screw.

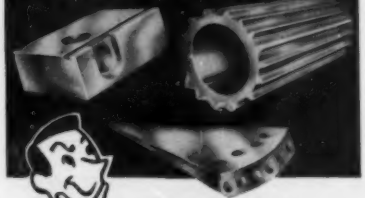


ENGINEERED PRECISION CASTING CO.

MORGANVILLE, N. J.

LIST NO. 4 ON INFO-COUPON PAGE 169

DO YOU HAVE AN IDEA...





THAT SOME FUNCTIONAL METAL PART COULD BE MADE BETTER OR CHEAPER BY ALUMINUM EXTRUDING?

Bring your idea to specialists in adapting aluminum extrusions to new functional parts applications. G. E. I.'s engineers are ready to consult with you, without obligation, on one part or a million.

GENERAL EXTRUSIONS, INC.
4040 LAKE PARK RD., YOUNGSTOWN, OHIO

LIST NO. 141 ON INFO-COUPON PAGE 169

RUST-LICK
IN
AQUEOUS SYSTEMS

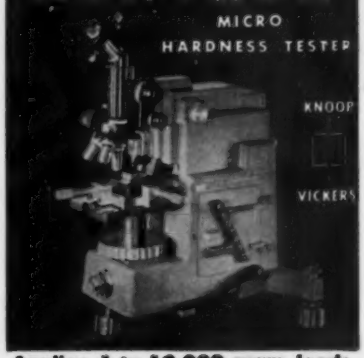
Grade "C-W-25"
Non-flammable
Non-toxic
Aqueous Oily Film
Protects Ferrous Parts
for Long Periods
Indoor Storage

Write for free sample and brochure
Specify Grade "C-W-25"

PRODUCTION SPECIALTIES, INC.
755 BOYLSTON STREET
BOSTON 16, MASS.

LIST NO. 121 ON INFO-COUPON PAGE 169

KENTRON
MICRO
HARDNESS TESTER



Applies 1 to 10,000 gram loads

Write for Bulletin

Kent Cliff Laboratories Div.
The Torsion Balance Company
CLIFTON NEW JERSEY

LIST NO. 53 ON INFO-COUPON PAGE 169

HARDNESS TESTING
SHORE SCLEROSCOPE



Pioneer American Standard Since 1907

Available in Model C-2 (illustrated), or Model D dial indicating with equivalent Brinell & Rockwell C Hardness Numbers. May be used freehand or mounted on bench clamp.

OVER 40,000 IN USE

SHORE INSTRUMENT & MFG. CO., INC.
90-35M Van Wyck Exp., Jamaica 35, N.Y.

LIST NO. 133 ON INFO-COUPON PAGE 169

The 1955 Supplement to the Metals Handbook



- 200 Large Pages
- 214 Tables
- 256 Charts
- 411 Illustrations

Order now a copy of the clothbound 1955 Supplement to increase the usefulness of your ASM Metals Handbook. The Supplement gives an authoritative survey of facts on these subjects:

Sheet Steel
Press Forming Dies
Gray Cast Iron
Stainless Steel
Aluminum Alloy Castings
Closed-Die Forgings
Helical Steel Springs
Surface Finish
Residual Stresses
Electroplated Coatings
Induction Hardening
Flame Hardening
Gas Carburizing
Control of Surface Carbon
Heat Treating of Tool Steel
Manual Arc Welding
Metal Cleaning Costs
Creep and Creep-Rupture Tests
Radiography of Metals
Macro-Etching of Iron & Steel

Each article gives a comprehensive coverage of its subject, with information limited to essential facts. This authoritative survey was prepared by 19 ASM technical committees comprising 179 outstanding engineers. For complete details of contents, see August 15, 1955, issue of Metal Progress, which contains the articles being offered in this clothbound edition. Price is $4.00 to ASM members, $6.00 to nonmembers.

American Society for Metals
Room 790, 7325 Euclid Ave.
Cleveland 3, Ohio

Please rush me the 1955 Supplement to the Metals Handbook.

.....

.....

.....

.....Zone.....State.....

☐ Check enclosed ☐ Bill me ☐ Bill my company

CIRCO Since 1923

Specialists in All Phases of METAL CLEANING EQUIPMENT

- DEGREASERS • AGITATING WASHERS • PICKLERS
- PHOSPHATIZING WASHERS • ALKALINE WASHERS
- FLOW COATING SYSTEMS • "SPOTLESS" DRYERS
- OVENS • ULTRASONIC CLEANING EQUIPMENT

We will be happy to send a sales engineer to help you with any metal cleaning equipment problem. Complete information on request.

- CIRCO-SOLV (Trichlorethylene)
- PER-SOLV (Perchlorethylene)

CIRCO EQUIPMENT COMPANY

81 Terminal Avenue, Clark, New Jersey • FUlton 8-2600

LIST NO. 10 ON INFO-COUPON BELOW

ZERO REFRACTORY PRODUCTS



Castables and Cements

FOR ALL TEMPERATURE AND STRENGTH REQUIREMENTS

Immediate Delivery

Send for Catalogue 102

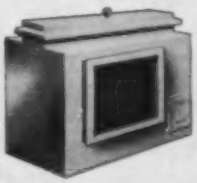
STANDARD FUEL ENGINEERING CO.

667 S. POST • DETROIT 17, MICH.

LIST NO. 151 ON INFO-COUPON BELOW

ARco AIR WASH SYSTEMS

PLATING • PICKLING • METAL CLEANING *FUME SCRUBBING*



• Reasonable initial cost . . . economical in operation . . . no moving parts . . . efficient in performance . . . compact—requires little space . . . standard units—7200 to 57600 C.F.M. Write Dept. "MP" for complete information.

AUTOMOTIVE RUBBER CO. • INC.

12550 BEECH ROAD • DETROIT 39, MICH.

LIST NO. 154 ON INFO-COUPON BELOW

READERS' INFO-COUPON SERVICE, METAL PROGRESS
7301 Euclid Avenue, Cleveland 3, Ohio

Please send further information, as checked at the right, on the advertisements in the Bulletin Board with numbers I have listed below—

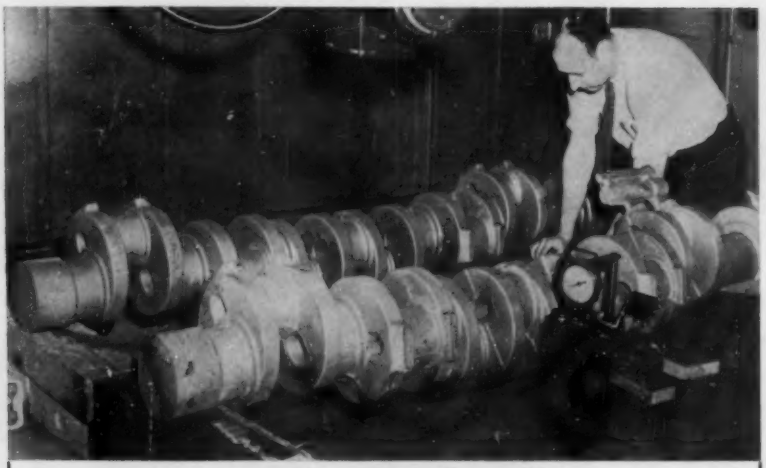
(Bulletin Board Item Number)	(Please check) Send Catalog or Engineering Data	Send Price Info	Nearest Source of Supply
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐

Your Name.....**Title**.....

Company.....

Street.....

City.....**Zone**.....**State**.....



Faster Brinell Hardness Tests—

Large cumbersome parts can be tested easily and accurately with a King Portable Brinell Tester. The King Portable is taken to the work, not the work to the tester.

No need to cut samples for testing; no need for elaborate fixturing to hold heavy parts in a stationary testing machine. King Hardness Testers can be carried anywhere and can make tests in any position. Automatically locks in position.

The King Portable saves handling time; takes fast, accurate tests; and is so versatile, it soon pays for itself.

Write for Complete Description and Specifications

KING TESTER CORPORATION

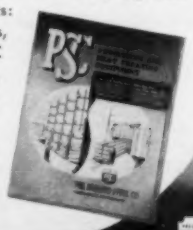
446 NORTH 13th STREET • PHILADELPHIA 23, PA.

PSC Sheet Alloy Radiant Tubes COST LESS • LAST LONGER



Let Us Demonstrate This

If you are using cast alloy tubes, we can quote you substantially less on our all-sheet alloy tubes. And, with dies on hand for many commonly used sizes of return bends, we can frequently save our customers this important cost. Records of scores of installations show PSC "Thin Wall" tubes are giving much longer service life. For instance, Michigan Malleable Iron Co. reports: "We show an average life of over 3½ years for your fabricated tubes, which is about double our experience with cast alloy tubes". In PSC tubes the return bends are of the same metal and thickness as the legs, promoting uniform flow of gas and minimizing carbon build-up and consequent burn-out. Precision-assembled in any design or dimension. Also sheet-alloy heat-treating retorts and covers, boxes, baskets, fixtures, tubes, etc. We invite your inquiries.



Send for PSC Heat-Treat Catalog 54

THE PRESSED STEEL CO. • Wilkes-Barre, Pa.

Modern Basic Bessemer Process

Digest of "Engineering Aspects of Modern Basic Bessemer Plants", by C. Herrmann, *Journal*, Iron and Steel Institute, Vol. 185, February 1957, p. 242-260.

THE AUTHOR traces the history of the basic bessemer process in Europe from its initial development by Gilchrist in 1879 to the present time. Steel production in Europe by this method increased from 2.5 million tons in 1890 to 26.5 million tons in 1955. Four distinct stages in this development are discussed and drawings of basic bessemer plant equipment and layout at the various stages are shown.

The first of the four stages consisted of a circular arrangement of converters. It made use of stationary slewing cranes for charging and teeming, and circular casting pits. This stage was followed by the arrangement of the converters in a row. It used steam-driven casting cars, and had teeming pits parallel to the converter aisle. Increase in converter capacity to 20 tons signaled the start of the third stage. Mixers for storing hot metal were introduced, along with the use of heavy overhead traveling cranes for handling hot metal and steel for teeming. The fourth and last stage of development has been initiated only in the past decade and is characterized by a significant increase in converter sizes to 50 tons (80 tons in the United States). This stage is further characterized by a far-reaching rationalization of the operating process. The use of oxygen-enriched or pure oxygen blasts has necessitated special constructional changes and control problems.

Until the last decade there was little change in metallurgical practices for the bottom-blown basic converter. As indicated above, most of the changes related to improvements in metal handling equipment and in plant layouts.

The author gives a detailed discussion of the operations and layout of four of the newest bottom-blown converter plants built in Europe during the past ten years. These are the Sollac's Works in France, which has four 50-ton bottom-blown vessels and uses oxygen-enriched blast in the first stage of blowing and oxygen-



Money-saving wrought Inconel pot in neutral salts bath operates 16 hours a day at 1550°F. This Inconel pot has lasted 2,080 hours *longer* than previous pots used by General Heat Treating Co., Syracuse, N. Y.

Now—with wrought Inconel— pots for this neutral salts bath last 18 times longer!

Here's the way General Heat Treating Company cut the cost of their neutral salts bath: they installed wrought Inconel* nickel-chromium alloy pots.

Formerly, pots lasted only 120 hours — then let go. Costly and time-consuming.

Now, things are different at General! Their first wrought Inconel pot lasted 2200 hours . . . 18 times longer! Pot operating costs dropped to 18¢ an hour compared to 75¢ an hour for previous pots. Downtime, too, was cut to the bone.

When you have corrosion problems at sustained high temperatures — even up to 2100° F. — think of Inconel alloy. It's proved itself over and over in baskets, hooks, retorts, muffles . . . in heat-treating equipment of all kinds. This alloy resists severe furnace atmospheres, stands up to thermal shock, maintains its strength.

For ideas on how to boost the service life of *your* equipment, get Inco's booklet, "Keeping Operating Costs Down When Temperatures Go Up." It tells what readily-fabricated Inconel can do. Write *today*.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK Nickel Alloys

Inconel...*for long life at high temperatures*

Basic Bessemer . . .

steam blast in the last stages to control the nitrogen content of the steel; the Steel Company of Wales, Ltd. with four 50-ton converters where enriched air and oxygen-steam blowing is also practiced; the Hadir Works in Luxembourg which has five 50-ton vessels and three 1300-ton mixers; and the Salzgitter plant in Germany.

All of the new bottom-blown converter plants have added oxygen producing units and usually include a refractory-lined fume hood above the converter. Sometimes large gas cleaning units are used to reduce the dust content. Because of the higher temperatures developed in blowing with oxygen-enriched air, larger additions of cooling agents must be made to the hot metal bath. These are steel scrap (15% of the charge weight), iron ore or roll scale. The final blowing stage is usually done with a 50-50 mixture of oxygen and steam to control both temperature and nitrogen content of the steel.

Scrap handling methods, disposal of the valuable high-phosphorus slag, converter construction, and methods of making the dolomite-tar mixture which is standard for the refractory lining of the converters are discussed. Many new control instruments are also described.

The remarkable developments in this old process, mainly as a result of cheap oxygen, are listed below:

1. Converters have capacities of 50 to 80 tons.
2. Casting cars have been replaced by crosswise traveling steel transfer cars which transport the steel ladles to the casting bay.
3. Blowing with oxygen-enriched air plus oxygen-steam mixture has become indispensable in improving steel quality.
4. Solid additions of cooling agents are charged by highly mechanized processes.

So far only the bottom-blowing type of converter has been considered. A new process, called the LD Process, has been developed during the last decade at the two Austrian steelworks, Voest in Linz and the Alpine-Montan-Gesellschaft in Donawitz, in which technically pure oxygen is blown onto the hot-metal bath in the converter through a water-cooled lance. The oxygen converter, too, is lined with tar dolomite bricks and has a closed bottom, in contrast to the basic bessemer converter. The lance is positioned at a convenient height above the bath and blows oxygen onto and into the bath at a high rate. The method of working is similar to that used in the air-blowing process. Lime, cooling scrap, and molten pig iron are charged into the converter, the oxygen lance is introduced, and the oxygen supply turned on. During the blowing process cooling agents such as ore, scrap, and limestone chippings are charged through chutes into the blowing converter from the lime platform in order to control the slag and the temperature.

The converter nose of normal basic bessemer converters is inclined to one side, so that the tilted converter can receive the heat without the tuyere bottom coming into contact with the bath of hot metal. There is no need for this in oxygen-

GIVE METALS A COLD TREAT



STABILIZE ALLOY STEEL by complete change of austenite to martensite.

TOUGHEN METALS, increase hardness and life of perishable tools up to 400%.

STRESS-RELIEVE CASTINGS of magnesium, aluminum and cast iron . . . with SUB-ZERO Chilling!

- **Capacity: 400 BTU's per hr. at −120° F.**
- **2 cubic foot chamber**
- **All steel constructiotn**
- **Hermetically sealed refrigeration system**
- **Easy "plug-in" installation**
- **Heating unit, observation window, other accessories available.**

There is a complete range of models, sizes and special designs to suit your job requirements. Write today for Catalog on the full line.

Cincinnati

CINCINNATI SUB-ZERO PRODUCTS

General Offices and Plant

3930-R7 Reading Road **Cincinnati 29, Ohio**

WHEN YOU SEE THIS TRADEMARK



on a heat or corrosion resistant alloy casting



you know it stands for nearly a quarter century

of Quality . . .
Service . . .
Integrity . . .

No finer casting can be made.



the fahralloy co.
150th & Lexington Ave. - Harvey, Illinois
In Canada - Fahralloy Canada, Ltd., Orillia, Ontario

WILEY — BOOKS

1. STRESS CORROSION CRACKING AND EMBRITTLEMENT

Edited by WILLIAM D. ROBERTSTON, Yale University

Papers from the Electrochemical Society's symposium on Stress Corrosion Cracking cover major developments of the last twelve years, reflecting important work done in industry and university laboratories of four countries. Extensive consideration is given to aspects affecting stability and safety of structures. Among the topics discussed are: laboratory techniques, chemical cracking, the role of boundary adsorption, structure of grain boundaries, hydrogen in iron and its alloys, and stress corrosion cracking in austenitic stainless steels, in a magnesium alloy, in homogeneous alloys, and mild steels.

1956 • 202 pages 115 illus. $7.50

2. BRITTLE BEHAVIOR OF ENGINEERING STRUCTURES

By EARL R. PARKER, University of California

Contains a thorough discussion of the theories and mechanisms of failure, a review of test methods used for evaluating relative brittleness, interpretations and summaries of test results, a discussion of the effects of welding composition variations on notch toughness, and a report of service failures. Prepared for the Ship Structure Committee under the general direction of the Committee on Ship Steel, National Academy of Sciences, National Research Council.

1957 323 pages 209 illus. $6.00

3. THE SCIENCE OF ENGINEERING MATERIALS

Proceedings of the Carnegie Conference on the Impact of Solid State Science on Engineering Materials.

Edited by J. E. GOLDMAN, Ford Motor Company

A series of integrated essays by leading scientists and engineers. Introduces the basic principles of solid state physics as applied to the explanation of properties of materials, and offers qualitative explanations and interpretations of a variety of materials, such as metals, alloys, and semiconductors, as well as cements, polymers, and glasses.

1957 528 pages 245 illus. $12.00

4. ARCS IN INERT ATMOSPHERES AND VACUUM

Edited by W. E. KUHN, The Carborundum Company. With 23 contributors

The first book of its kind to treat the subject of arcs in inert atmospheres and vacuum, and their applications to the melting of metals by the "cold crucible" process. Also discusses the chemical and metallurgical applications of the "high intensity" arc. Sponsored by The Electrochemical Society, Inc.

1956 188 pages Illus. $7.50

5. INTRODUCTION TO SOLID STATE PHYSICS—Second Edition

By CHARLES KITTEL, University of California

This new edition stresses fundamental theory of simple models of solids and includes fuller explanations of basic concepts. It contains new material on such topics as diffusion, dislocations, alloys, semiconductors, photoconductivity, luminescence, and imperfection in solids.

1956 617 pages 363 illus. $12.00

6. BORON, CALCIUM, COLUMBIUM, and ZIRCONIUM in IRON and STEEL

By R. A. GRANGE, United States Steel Corp.; F. J. SHORTSLEEVE; D. C. HILTY, W. O. BINDER, all of the Electro Metallurgical Co.; G. T. MOTOCK, Olin Mathieson Chemical Corp.; and C. M. OFFENHAUER, the Electro Metallurgical Co.

A concise summary of all the available data on four of the alloying metals for iron and steel which have become important since World War II. Complete, accurate information, some of it appearing for the first time in published form. The fourth publication in the Alloys of Iron Research New Monograph Series, Frank T. Sisco, Director.

1957 533 pages 207 illus. $14.00

7. SEMICONDUCTOR ABSTRACTS, Volume III 1955 Issue

Compiled by the BATTELLE MEMORIAL INSTITUTE, and sponsored by The Electrochemical Society, Inc.

1957 322 pages $10.00

Mail the coupon for ON-APPROVAL copies

JOHN WILEY & SONS, Inc. MP-97
440 Fourth Ave., New York 16, N.Y.

Please send me a copy of the book(s) circled below to read and examine. Within 10 days I will return the book (s) and owe nothing, or I will remit the full purchase price (s), plus postage.

1 2 3 4 5 6 7

Name .....

Address .....

City ..... Zone ..... State .....

( ) SAVE POSTAGE! Check here if you enclose payment in which case we pay postage. Same return privilege, of course.

Basic Bessemer . . .

blown converters since they have a closed bottom. It is therefore possible to choose a symmetrical shape of the converter which is more favorable for blowing.

The use of an oxygen-enriched air blast in converters – and the increasing pollution of the atmosphere by converter exhaust gases, which it entails – make the installation of a waste-gas purifying plant desirable. Difficulties are associated with the development of such equipment because the incidence of waste gases is periodic and they have a very high temperature (about 3090° F.). During experiments lasting over many years it has been found that the gases can be cleansed of dust economically only if the high heat content of the waste gases is used to produce steam. This dispenses with any cooling plant, which would have to be set up in front of the purifying plant (and which would occasion high operating costs because of the constant need for cooling water). Moreover, if a cooling plant were used, the temperatures after cooling would still be so high that the flue would have to be lined or be cooled with water itself.

The first waste-gas purifying plant was built for oxygen-blowing converters, where sloppings are few, if any, in comparison with bottom-blowing converters, and the quantities of waste gas are significantly smaller. To utilize the thermal energy a waste-heat boiler was included and a deduster installed behind it. Such plant disposes of 98 to 99% of the dust, a degree of efficency which satisfies the existing regulations in many countries.

The author estimates that the cost of a new bottom-blown bessemer steelworks to produce 1 million tons per year would be 6.8 million pounds sterling and that a similar open-hearth steelworks would cost 40% more for the same output. (This does not include the capital cost of extra blast furnace capacity needed to supply the greater amount of hot metal required by the bessemer plant for the same ingot capacity). The top-blown oxygen converter plant would probably cost more because of the larger oxygen plant, dust control, and waste heat boiler equipment. E. C. WRIGHT

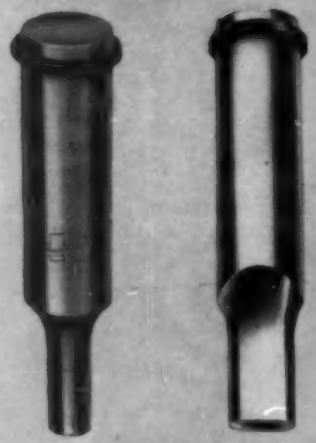
Here's why...

Ring Punch & Die, Inc. JAMESTOWN, NEW YORK

uses Latrobe's

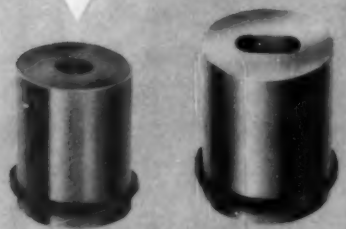
FREE MACHINING HIGH CARBON— HIGH CHROMIUM TOOL STEELS

for Standardized Precision Punches and Dies



TOOL LIFE INCREASED!

Screw machine operation increased from 45 pieces to 80 pieces per hour when machining Latrobe's GSN FM tool steel. In production, the cut-off and form tool life increased over 100% between grinds!



PRODUCTION DOUBLED!

Round hole dies are drilled and taper reamed. Oblong hole dies are milled and counterbored. Again, Latrobe's GSN FM tool steel resulted in savings—production per hour was doubled; cost of drills, end mills and reamers reduced!

EXCEPTIONAL WEAR IN USE!

Exhaustive field tests, conducted by Ring Punch and Die, Inc., have showed that GSN FM punches and dies give exceptional wear in actual production use. No loss of punch life, or chipping, was detected over that normally experienced when punches and dies were made of regular high carbon-high chromium steel without the "free machining" sulphide additives.

GSN FM is an oil hardening high carbon-high chromium steel possessing outstanding non-deforming characteristics in heat treatment. It contains sulphide additives that greatly improve its machinability. These alloy sulphides, as well as the important carbide particles, are evenly dispersed throughout GSN FM by Latrobe's exclusive DESEGATIZED® process of manufacture—your assurance of uniform tool steel quality.

Call your nearest Latrobe representative for complete data on GSN FM and other quality tool steels. A wide range of sizes for immediate delivery stocked at conveniently located warehouses.

Latrobe

STEEL COMPANY

Main Office and Plant: Latrobe, Pa.

Branch Offices and Warehouses Located in Principal Cities

Study of Wear Process

Digest of "Why Materials Wear", by Verne Pulsifer, *The Frontier*, Armour Research Foundation, Vol. 19, No. 4, 1956, p. 8-11.

IN PROBING the reasons and their correctives for the wear of structural materials, investigators must make full use of their knowledge of mechanics, metallography, metallurgy, chemistry, ceramics, statistical mathematics and the physics of heat and matter. In these wear studies, many of the newer scientific methods and devices become useful – strain gages, autoradiography, X-ray diffraction, amplified multiple recording apparatus and tracer techniques, to name but a few.

One observed paradox in this field of research is that service failures often prove not to be *wear* failures. The direct cause often turns out to be fatigue, although metallurgists are well aware of the importance of contributing effects of deformation, corrosion, fretting, seizing, overheating and other stress-inducing phenomena.

Little engineering information is available on wear rates for most material combinations, one probable reason being that there is deficient understanding of the tolerance for wear. Some data on the question are beginning to appear in the literature, but unfortunately the metallographic structures and compositions of the wear materials may be neglected. Thus, dry wear rates between brass members are meaningless without information on the structure of the brass – alpha? beta? leaded? cast or wrought? Structural variables have a vital effect on all materials where basic wear data are needed.

Extremes of wear rates are illustrated by fretting and seizing. Fretting, a mode of failure caused by vibration, once was thought to involve oxidation damage because fine wear particles were found to be oxides. Now, however, it is identified as strictly a vibration effect, because it has been observed in materials like glass and quartz. The small-order movements of fretting generate extremely fine wear products, so the process can be placed at the lower end of the wear behavior scale.

At the opposite end is seizing. It is known that metals bond perfectly if temperature and pressure are sufficiently high between their clean surfaces. Rubbing surfaces can be "cleaned" by flow, deformation, or wear in the absence of air, moisture or lubricants.

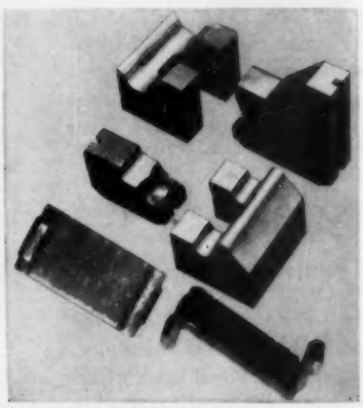
Paradoxically again, wear failures are more common among all types of ball and roller bearings than in sliding bearings, despite the reduced relative motion between the contact surfaces and the resulting longer wear life. Such bearings do not and cannot conform to the "classical" structure, since the primary requirement is shape and size rather than deformability.

Hardened and tempered steel (martensite) forms the basic structure of most ball and roller bearing surfaces, as well as of most cam and gear tooth faces. Dies, punches and forming tools of all types have deviated from the classical structure

50% to...???*

INCREASED PRODUCTION, PROVEN WITH . . .

Darwin PRK·33 TOOL STEEL



PRK-33 dies and automobile door hinge blanks. Stock ½" thick, H. R. 1020.

For the extra performance and savings you want from better wearing tools and dies—less downtime for retooling or regrinding and longer, more economical runs—it's not the first cost, but the "plus" of Darwin PRK-33 that counts. The unique composition of added Cobalt, Chromium, Nickel, Manganese and Molybdenum give PRK-33 both stainless and non-corrosive qualities —*plus, rigorous durability.* If you are now using standard 150 carbon, air hardening high chrome tool steel, it will pay you to call or write today about the savings you can effect with PRK-33.

*REPORTED BY PRK-33 USERS

Complete Line of highest grade Tool Steels, including PRK-33, DARWIN No. 1, NEOR, MINEOR, OHT, "MT6" and various grades of Hot Work Specialty Steels. Furnished in Bar Stock, Forgings, and Sand Castings, Drill Rod, Flat Ground Stock and Tool Bits.

Bulletin on Request.

- **HOT COINING DIES**—Increased production from previous high of 7,000 pieces to 16,100 (130% increase) without sign of heat or wear cracks.
- **KNURLING TOOLS**—Beats not only High Carbon—High Chrome but also High Speed Steels in many cases. One case reports 50% better than High Speed Steels.
- **DRAWING DIES**—Philadelphia concern did over 60,000 pieces per grind, against previous best record of 16,000.

DARWIN & MILNER Inc.

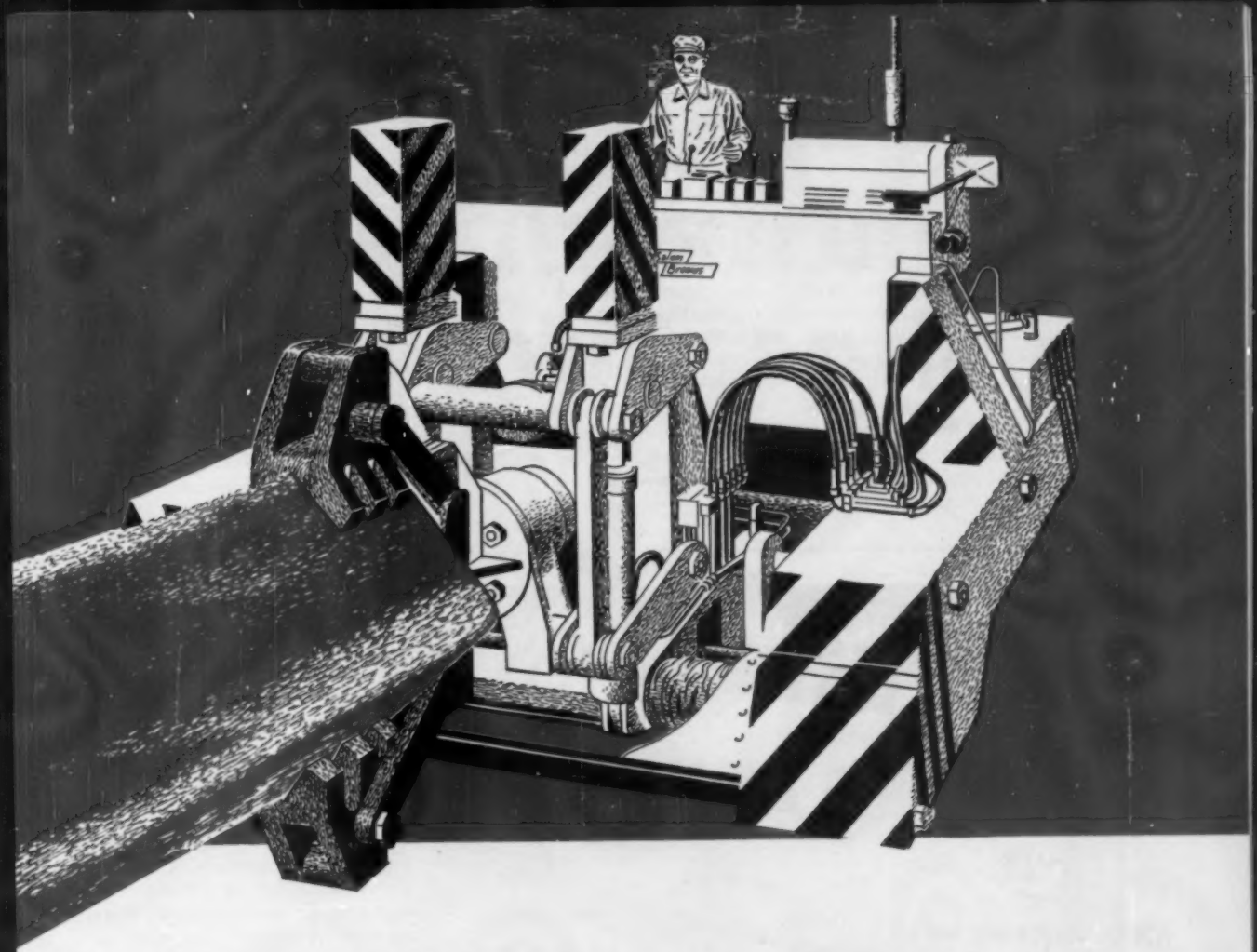
highest grade tool steels

2345 ST. CLAIR AVENUE ★ CLEVELAND 14, OHIO

• 1610 W. FIRST AVENUE • COLUMBUS, OHIO •

REPRESENTED BY

ZIV STEEL & WIRE CO., CHICAGO • DETROIT • ST. LOUIS • INDIANAPOLIS • TOLEDO • MILWAUKEE • M. G. OPP COMPANY, NEW YORK CITY • PECK STEEL & DIE SUPPLY COMPANY, LOS ANGELES • CHARLES R. WEBSTER, PLAINVILLE, CONNECTICUT • CHARLES W. BRINGMAN, ORLANDO, FLORIDA



New Salem-Brosius Manipulator

adds speed, safety and economy to heavy forging

This completely new Salem-Brosius all-hydraulic Auto-Floor Manipulator meets the trend of industry toward hammer and press forging of high alloy, stainless, and tool steels, and the many new extremely hard refractory-type alloys. The forging of these metals necessitates manipulating equipment of extreme ruggedness and durability.

This new machine, with its greater mass, new shock absorbing principles, heavier construction, and a new and superior hydraulic system, offers long, trouble-free service, low-cost maintenance, and increased finished forging production.

At hammer or press it raises, lowers, tilts, rotates or laterally moves the hot stock, satisfying handling requirements. Also, it can charge or draw forge shop furnaces, and operate with the facility of a fork-lift truck in billet handling. Call for a visit from a Salem-Brosius forging expert to show you how you can benefit from the use of this manipulator. There is no obligation.

SALEM-BROSIUS, INC.

CARNEGIE, PENNSYLVANIA

In Canada: Salem Engineering Limited • 1525 Bloor Street West, Toronto 9, Ontario

SPECIAL MECHANICAL EQUIPMENT • INDUSTRIAL HEATING FURNACES • MATERIALS HANDLING EQUIPMENT

Wear Process . . .

because their primary requirement is to hold tolerances and shape, rather than to conform to a running member such as a bearing.

Another class of wear resistant structures includes composite forms such as nitrided steels, chromium-plated materials, carburized steels, steel-backed silver or cadmium. But the cemented carbides have led the way back to the classical structure for many severe wear applications such as wire drawing, machining and rolling. They provide in a single material both the requirements for wear resistance and shape conformity during service.

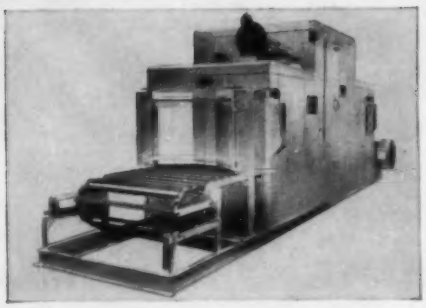
A structure found by metallurgists to reduce wear rate sharply consists of oxide wear particles from the parent material embedded in that material at extremely high service temperatures. An example is a high-temperature valve and valve insert combination. The hard, incompatible oxides originating in wear service in the seat insert substantially-reduced friction and the resulting wear dropped by several magnitudes.

Another paradox is that the wear process itself produces a structure capable of arresting wear!

ARTHUR H. ALLEN

YOUNG BROTHERS OVENS

to meet Your REQUIREMENTS for



Conveyor Oven for light alloy processing

Design production ECONOMY

A wide variety of standard and special Young Brothers Ovens and Furnaces are available to meet your specific needs for Annealing and Tempering, Drying and Impregnating, Aging, Normalizing, Stress Relief, Preheat, Homogenizing and many others. They are engineered and built to meet the most exacting requirements and they are backed by more than 60 years of experience devoted to the development of Batch and Conveyor Ovens for new processes, materials and products.

Exclusive features of Young Brothers Ovens lead to savings in production time, prevention of loss of material and product improvement. Experienced engineers are available for consultation without obligation. Write for new Bulletin 157.

YOUNG BROTHERS COMPANY

1829 COLUMBUS ROAD • CLEVELAND 13, OHIO

The Mechanism of Craze-Cracking

Digest of "The Craze-Cracking of Metals," by L. Northcott and H. G. Baron, *Journal* Iron and Steel Institute, Vol. 184, December 1956, p. 385-408.

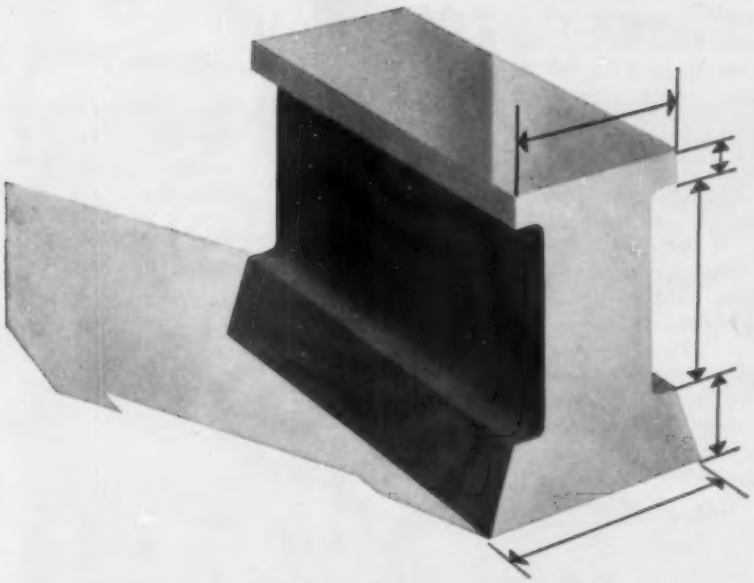
SURFACE FAILURE of metals produced by repeated thermal stresses is known to occur in metal surfaces submitted to very rapid heating followed by rapid cooling. The phenomenon, called craze-cracking, has been observed in a variety of components in industrial equipment such as brake drums, railway wheels, ingot molds, hot rolls, die-casting and forging dies. Although some observations concerning these failures have been reported in the literature, very little original work has been done to date and this paper is probably the first attempt made to determine the significant factors influencing the mechanism of craze-cracking.

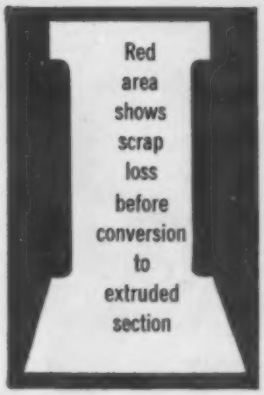
The experimental work was carried out by intermittently heating one face of a small specimen by means of a 25-kw. high-frequency generator at a frequency of 500 kc. The main body of the specimen was kept cool by water circulation. Process timers were used to control the on-off cycle to produce an automatic sequence. Standard chromel-alumel thermocouples spot welded to the surface indicated the temperature on a galvanometer. Time-temperature records were obtained by means of a d-c. amplifier and an extra-high-speed recorder. These records showed a rate of heating of about 1830° F. per sec. at the beginning of the cycle.

The variables studied included: (*a*) carbon content from 0.32 to 0.99% in base composition containing 0.6% manganese, (*b*) alloying elements on a base composition containing 0.35% carbon, (*c*) minimum and maximum temperatures used in the cycle and number of cycles, (*d*) nature of the atmosphere, (*e*) rolling and forging directions and (*f*) stress concentrations due to surface preparation or to metallurgical notch effects caused, for example, by graphite flakes in cast iron.

The experimental work showed some very interesting results. The tendency to craze-cracking increased with the carbon content, the cracks

Cost per clamp cut from $1.06 to 58¢ with J&L hot extruded cold drawn section





This manufacturer cut the cost of contact clamps 45% by converting to J&L extruded sections. Previous cost of $1.06 per part involved costly milling and scrap loss from cold drawn 1½" x 1" flats.

Here's how extruded sections can cut your cost:

1. Eliminate machining and finishing operations.
2. Reduce scrap losses almost to zero.
3. Eliminate cost of casting and forging intricate sections.
4. Reduce inventories because extrusions are quickly available.

Investigate this new production technique for your shape profiles—within present limits of a design which can be inscribed in a three-inch circle. Available in a wide range of carbon and alloy steels. For specialty alloy and tool steels, submit inquiry. Get complete details by writing to the Jones & Laughlin Steel Corporation, Dept. 405, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

J&L STEEL

Jones & Laughlin

... a great name in steel

Highly accurate

2-MINUTE CARBON analysis

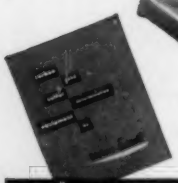
IRON
STEEL
PETROLEUM CATALYST
STAINLESS ALLOYS
ORGANIC CHEMICALS
FOUNDRY SANDS

Determine carbon content in just 2 minutes! No complicated mathematics; eliminates costly time-consuming routines. Accurate analysis of borings, mill chips, crushed samples, pellets, etc. Dietert-Detroit testing equipment widely used in company laboratories and institutions of every description for over 18 years.



*SULFUR DETERMINATORS ALSO AVAILABLE.

DIETERT-DETROIT CARBON Determinator NO. 3003



for the asking

Free Dietert-Detroit 16 page Catalog illustrates both Carbon and Sulfur Determinators and complete line of accessory equipment.

HARRY W. DIETERT CO.
CONTROL EQUIPMENT
9330 ROSELAWN DETROIT 4, MICHIGAN

Send me your Carbon-Sulfur Determinator Catalog

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ STATE_____

Craze-Cracking . . .

being deeper the higher the carbon content, at least for a temperature cycle of from 105 to 1560° F. in air. Separate additions of manganese, nickel, chromium and molybdenum also increased the cracking tendency while silicon, cobalt and vanadium (up to 0.3%) did not.

The maximum temperatures reached had curious effects on the cracking phenomenon. In a 0.34% carbon steel the greatest rate of cracking occurred with a maximum cycle temperature of 1830° F., the rate of cracking falling off with higher and lower temperatures. This critical temperature differed for different steels and a series of curves is presented to show the effect on crack depth of steel composition and temperatures reached.

On the other hand, the minimum temperature of the cycle had little effect on craze-cracking when kept below the M_f temperature. However when the minimum temperature was above the M_f point, the surface layers were maintained in the austenitic condition and the incidence of craze-cracking considerably reduced.

Various atmospheres were used to prevent oxidation at high temperature. No marked effect of the atmosphere on rate of cracking was observed.

The effect of rolling direction on craze-cracking was also studied. When the rolling direction was normal to the edge being studied, sharper cracks were formed and the rate of cracking was increased. Transverse notches cut into the surface accelerated the rate of craze-cracking even if these notches were no more than a few thousands of an inch in depth. This notch effect was also observed in cast iron containing flake graphite, where the rate of craze-cracking was higher than in nodular iron.

These results can be best interpreted by consideration of the stress-strain cycle which the surface undergoes during the thermal cycles. In order to construct the stress-strain cycle one has to know the variation with temperature of the elastic modulus, yield stress and thermal expansion for both rapid heating and cooling. Such data pertaining to a few steels have recently been

Tempilstiks°

THE CRAYONS THAT TELL TEMPERATURES



IT'S THIS SIMPLE

- Select appropriate TEMPILSTIK° for the working temperature you want.
- Mark your workpiece with it.
- The TEMPILSTIK° mark melts as soon as its temperature rating has been reached.

Accuracy within 1% of rated melting point.

Also available as TEMPILAQ° (liquid form) and TEMPIL° PELLETS

63 different temperature ratings available

For information and samples, send coupon

Tempil° CORPORATION
134 West 22nd St., New York 11, N.Y.
Send information on:

☐ TEMPILSTIK° ☐ TEMPILAQ°
☐ TEMPIL° PELLETS
☐ Send booklet "How Temperatures are Measured"
☐ Send sample pellets for _____°F temperature

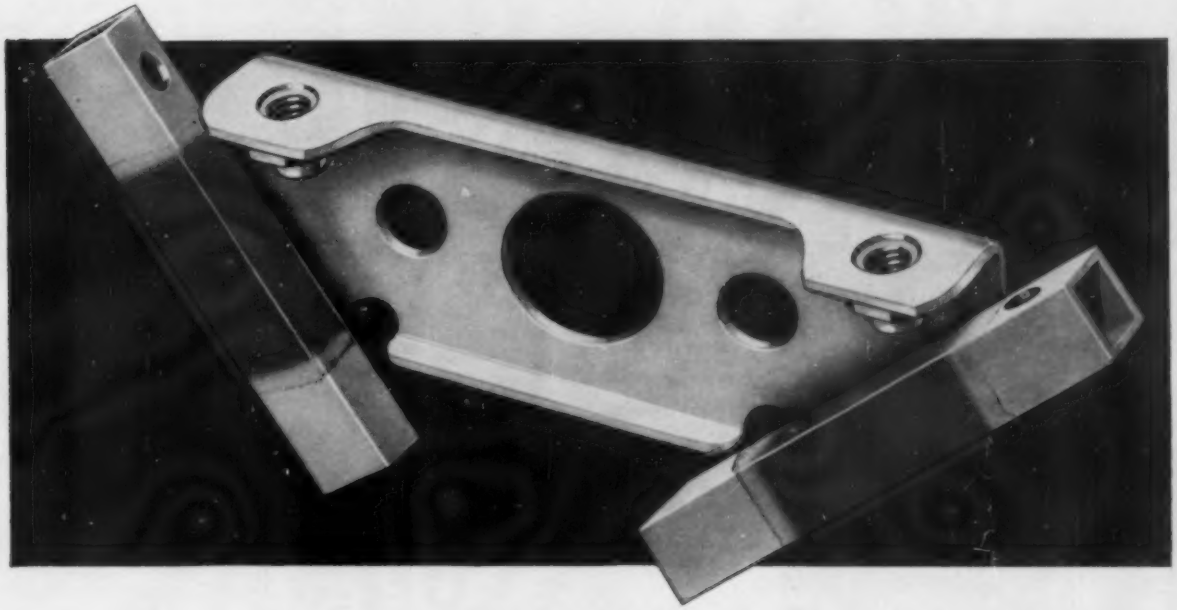
Name_____
Address_____
City_____
State_____

Visit our Booth #1041 at the Chicago Metal Show November 4-8, 1957



Jack & Heintz Saves $15.84 Per Hour...

with TOCCO* *Induction Brazing*



Brazing Costs Down—When Jack & Heintz engineers switched from torch brazing to automatic induction, brazing cost of these inverter brush mounts fell from $.05 to $.006 each—a reduction of 83% in direct labor costs alone! Additional savings result because less cleaning is required after TOCCO, and fuel costs are much lower, too.

Brazing Production Up—While costs dropped, production on the part zoomed—from 40 to 360 brazed assemblies per hour. Furthermore, rejects and scrap, formerly high, are now negligible.

Versatility—The part shown is just one of over 25 parts, large and small, which alert J & H engineers have converted from old-fashioned brazing methods to modern, automatic TOCCO. Overall brazing costs (TOCCO brazing versus former methods used) are down 75%—brazing speed, up 100%.

If the manufacture of your product involves brazing, heat-treating, forging or melting of ferrous or non-ferrous metals, don't overlook TOCCO as a sound method of increasing production, improving product quality and slashing costs.



THE OHIO CRANKSHAFT COMPANY

Mail Coupon Today—**NEW FREE Bulletin**

The Ohio Crankshaft Co. • Dept. R-9, Cleveland 5, Ohio

Please send copy of "Typical Results of TOCCO Induction Brazing and Soldering"

Name_____

Position_____

Company_____

Address_____

City_____ Zone____ State_____

Craze-Cracking . . .

published and by using them the author was able to determine the stress-strain cycles in uniaxial and biaxial systems.

The final analysis of these results may lead the way to the development of materials with increased resistance to craze-cracking. This could be done by increasing the yield stress or lowering the Young's modulus and coefficient of thermal expansion. Other factors such as phase changes and ductility must be taken into account. However, tables of properties are given for a large number of metals and the ratio $E\alpha/K$ determined, where E is the Young's modulus, α the coefficient of linear expansion and K the thermal conductivity. This ratio is the nearest one to a general thermal shock parameter.

Finally it was concluded that when there is a phase change in the cycle, craze-cracking may be associated with ductile fracture in a notched-bend test. When no phase change is present, surface cracking is probably closely related to the fatigue phenomenon.

H. P. TARDIF

ECONOMICAL

EXTRA LONG LIFE

RETORTS



vertical corrugation lengthens service life of retorts

Repeat purchases by prominent Heat Treaters is their endorsement of the superior performance and economy of our Vertically Corrugated Retort.

We will cooperate with your Engineering Organization in designing your Alloy steel fabrications and other metal and non-ferrous metal fabrications.

We have facilities to form 5/8" thick by 10 ft. long steel in our 500-ton Press Brake; heavier plate in shorter lengths. We also have facilities for roll forming heavy and thin wall cylinders to almost any diameter you specify.

We have 25 years experience fabricating for the Heat Treating Industry and corrosion resisting metals for the Chemical Processing Industries.

We solicit your inquiries for Retorts, Boxes, Baskets, Trays, Radiant Tubes and Fixtures etc. used in the Heat Treating Industry.

For further information send for literature

ALUMINUM and ARCHITECTURAL METALS COMPANY

Heat Treating and Industrial Processing Accessories Division

1974 Franklin Street
LOrain 7-6880
Detroit 7, Michigan

Sulphidizing in Fused Salts

Digest of "Sulphidizing in Fused Salts", by E. M. Morozova and F. R. Florensova, *Stanki I Instrument*, Vol. 27, No. 5, 1956.

THE EFFECT of the composition of the sulphidizing environment on two low-alloy steels and a cast iron was investigated. The steels were 40 Kh (C 0.35 to 0.45%, Mn 0.50 to 0.80, Si 0.17 to 0.37, Cr 0.80 to 1.10, Ni 0.40 max.) and 38 Kh MYUA (C 0.35 to 0.42%, Mn 0.30 to 0.60, Si 0.17 to 0.37, Cr 1.35 to 1.65, Ni 0.40 max., Mo 0.30 to 1.50, Al 0.70 to 1.10). The cast iron, designated Ch 21-40, had a tensile strength of 30,000 psi.

In the initial work a bath of 73% potassium ferrocyanide, 17% sodium thiosulphate was used at 1020 to 1060° F. It was found that the surfaces of the metals were saturated with sulphur and nitrogen. The effect may be attributed to the formation of active nitrogen and sulphur formed by interaction between the sulphur and nitrogen-containing salts as follows:

$$Na_2S_2O_3 \rightarrow Na_2SO_3 + S$$

$$K_4Fe(CN)_6 \rightarrow 4KCN + Fe(CN)_2$$

$$2KCN + O_2 \rightarrow 2KCNO$$

$$4KCNO + 3Na_2SO_3 \rightarrow 4N + 3S + K_2CO_3 + 3Na_2CO_3 + K_2O$$

The results of the second part of the work showed that the maximum depth of penetration of the "case" was obtained in a bath containing 22% sodium chloride, 18% barium chloride, 40 to 43% potassium bisulphate, 10% sodium sulphite and 7 to 10% potassium ferrocyanide. In this bath, at 1020 to 1040° F., the depth of sulphidizing increased with time of immersion. Four hours treatment at the above temperature produced a case depth of 0.012 in. in the steel and 0.011 in. in the cast iron.

Lubricated and unlubricated reciprocating-motion wear tests were carried out at a sliding rate of 226 ft. per min. and at pressures of 7 and 142 psi. The unlubricated tests were made on sulphidized specimens and lubricated tests on as-received specimens. The wear after 30 hr. was about the same on both specimens. Sulphidized cast iron specimens under similar testing conditions were shown to be superior



For better service to you Jessop acquires Green River Steel Corporation

Green River Steel Corporation of Owensboro, Kentucky, one of the newest alloy steel plants in the country, now is a wholly-owned subsidiary of Jessop Steel Company. This fact will result in benefits to the customers of both companies. If you buy steel from Jessop, you have been buying the broadest variety of top quality alloy, high-speed and stainless steels obtainable anywhere. Now with the splendid new and modern melting facilities of Green River in the picture, service from Jessop will be broader and quicker. If you are a Green River customer, you'll enjoy higher quality and more products and the benefits of the exclusive Dornin Process used by Green River which provides steel of unmatched forging qualities and grain structure. If you haven't been buying from either company, this is a good time to start. Write to Jessop.

These Jessop district offices and representatives can now service you with Green River Products

District Offices

Birmingham, Ala.
Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Detroit, Mich.
Hartford, Conn.
Indianapolis, Ind.
Los Angeles, Cal.
New York, N.Y.
Philadelphia, Pa.
Pittsburgh, Pa.
Toronto, Canada
Wallaceberg, Canada
Washington, D.C.

Representatives

Charlotte, N.C.
Kansas City, Mo.
Milwaukee, Wis.
St. Louis, Mo.
Utica, N.Y.

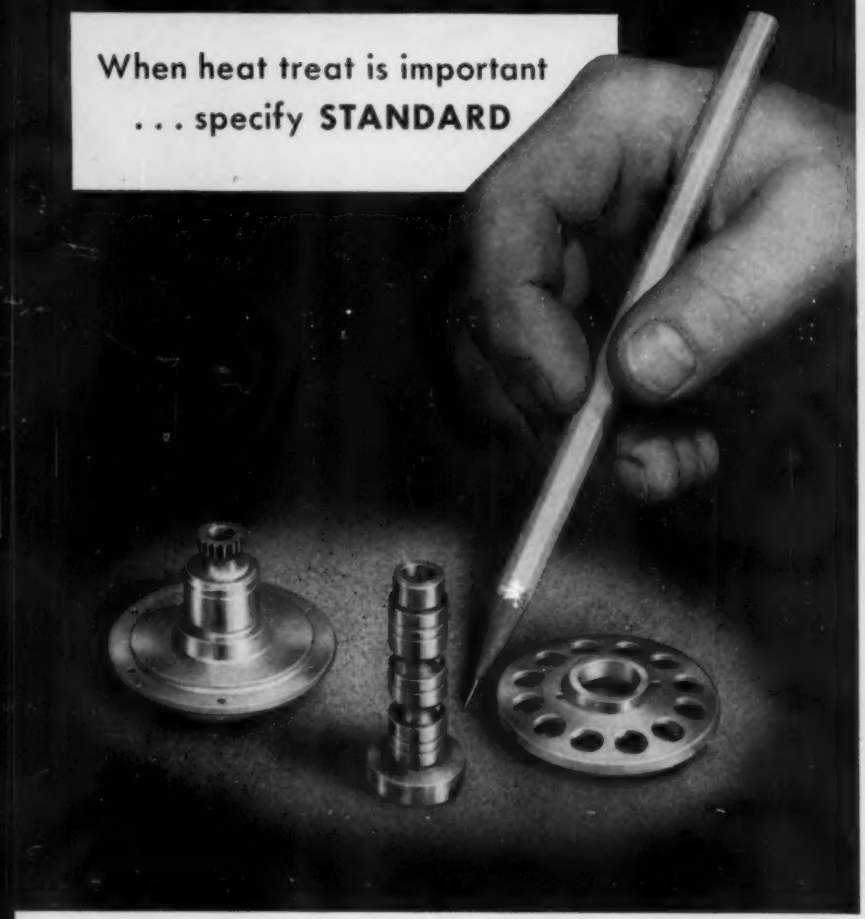
JESSOP

STEEL COMPANY • WASHINGTON, PA.

OFFICES IN PRINCIPAL CITIES

Jessop Steel of Canada Limited, Wallaceburg, Toronto

Jessop Steel International Corp., Chrysler Building, New York, New York



ROCKWELL 75+C
with .0005 "SUPERCASE"

Been looking for a parts casing process that gives you a "paper" thin, but extremely hard, wear-resistant surface? You've found it! It's "SUPERCASE" . . . a new process, *exclusive* with Standard Steel Treating Company, for nitriding all types of stainless steels. As in the typical "SUPERCASED" parts illustrated above, normal case depths range from .0003 to .0007 and the hardness factor approaches that of a diamond.

Consider, too, some of the other outstanding advantages of "SUPERCASE" over older nitriding methods . . . case depths are controlled to much finer limits . . . dimensional change is negligible . . . reworking, when needed, simply involves case removal, and selective hardening is easily accomplished by masking off areas that require machining after nitriding. Ask about "SUPERCASE" . . . write Standard for full details today!

Samples Processed Free of Charge

Standard Steel Treating Co.

"THE STANDARD OF THE HEAT TREATING INDUSTRY"

3467 LOVETT AVE. • DETROIT 10, MICHIGAN

Sulphidizing . . .

to etched and oiled specimens. The coefficient of dry friction of sulphidized cast iron under pressures of 314 and 626 psi. was 0.19 to 0.22 compared with 0.33 for the untreated metal. The coefficient of wet (oil-lubricated) friction was about 0.13 for both the sulphidized and untreated specimens.

W. A. MORGAN

Dimensional Instability of Turbine Shafts

Digest of "The Reverable Bending of Turbine Shafts With Temperature," by A. Barker and F. W. Jones, *Proceedings* of the Institution of Mechanical Engineers, London, Vol. 169, No. 41, 1955, p. 853-863.

IN THE reversible type of dimensional instability that is occasionally encountered in large rotating shafts, the shafts take on a characteristic bow when hot, and become straight again when cold. This bending is fully reversible and is due to variations in the thermal expansion coefficients throughout the body of the forging. Less troublesome types of thermal instability are those due to nonuniform surface conditions (differences in emissivity which are equalized by surface oxidation) or to the presence of internal stresses (which can be removed by prolonged heating).

In this investigation, the authors prove by a series of careful experiments that certain 0.30% C, 0.60% Mo turbine rotors had different coefficients of thermal expansion on opposite sides of the forging, and that this difference was not caused by chemical macrosegregation but by nonuniform heat treatment.

After demonstrating the chemical homogeneity of these rotors, they present evidence of the nonuniform microstructures. These structures were produced by a bainitic transformation on one side of the rotor while the material 180° away was undergoing a pearlitic transformation. Careful dilatometric studies showed that the bainitic material has a mean coefficient of thermal expansion (20 to 300° C.) of 13.04×10^{-6}, while the pearlitic structure was 12.69×10^{-6}. This difference of 0.35×10^{-6}

Highest Quality Ferroalloys

FERROSILICONS
HIGH-CARBON FERROCHROMES
LOW-CARBON FERROCHROMES
LOW-CARBON FERROCHROME SILICONS
SILICOMANGANESE
OTHER SPECIALTY ALLOYS

High quality ferroalloys are produced in the electric furnaces at Beverly and Jackson, Ohio, plants. Close metallurgical control results in uniform high quality day after day, month after month.

The plants are ideally situated for distribution of these products by rail, water, or truck.

A highly competent staff of metallurgical engineers is available for consultation. We welcome your inquiry.

PICKANDS MATHER & CO.

Cleveland 14, Ohio

CHICAGO • CINCINNATI
DETROIT • DULUTH
ERIE • GREENSBORO
ST. LOUIS • WASHINGTON

Serving Industry Since 1883

IRON ORE • PIG IRON • COAL • COKE • FERROALLOYS



GLOBE SILVERY IRON FERROALLOYS

Sold Exclusively by Pickands Mather & Co.

Turbine Shafts . . .

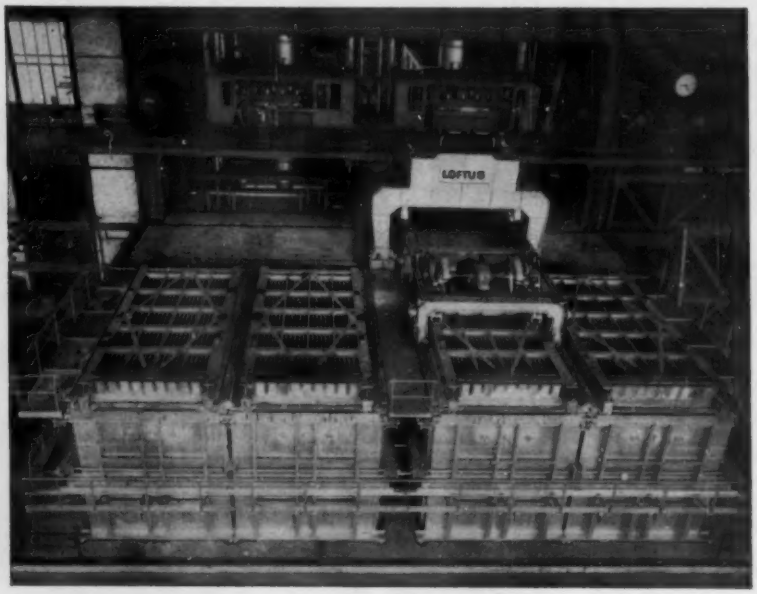
(3%) in the coefficients was shown to be of the proper sign and magnitude to account for the observed deflections. These differences in the microstructures and thermal expansion coefficients were also found in a second carbon-molybdenum steel rotor and they could also be produced by variations in the heat treatment of a 0.30% C, 0.65% Mo, 0.54% Ni steel.

Prolonged tempering treatments of these pearlitic and bainitic microstructures emphasized, rather than minimized, these differences in the thermal expansion coefficients.

Further work on the transformation kinetics of these steels demonstrated that these different structures could be produced under certain conditions of a commercial heat treatment if careful precautions were not taken to insure uniform austenitizing and normalizing conditions. A retreatment of an unstable rotor in accordance with these principles resulted in dimensional stability in the heat indication test. Austenitizing from a higher temperature and the addition of nickel to increase the hardenability were also suggested.

It was further observed by carbide extraction techniques that in all of these expansion coefficient differences, the high-expansion material had a carbide with the structure of Fe_3C while the low-expansion material had a carbide of the $M_{23}C_6$ structure. This result was felt to be consistent with a bainitic transformation forming Fe_3C, and a pearlitic reaction forming $M_{23}C_6$. The expansion coefficients of other steels which can transform with the formation of either Fe_3C or $M_{23}C_6$ can be varied in a similar manner. Other steels in which only one form of carbide is obtained show no such effect. Differences in the volume per carbon atom in these two types of carbides were suggested as part of the fundamental cause of the differences in the thermal expansion coefficients.

D. G. EBELING



LOFTUS PIT FURNACES

Insure top performance for each investment dollar, with the following distinct advantages:

- **Less investment with multi-purpose cover crane**
- **More production with heat acceleration**
- **More economy with integrated recuperation**
- **More uniform soak with flame tempering**
- **More setting capacity with top firing**
- **More flexibility with any fuel combination**
- **Less maintenance with flush carriage rails**

We solicit an opportunity to discuss your requirements—without obligation.

From first heat to heat treat, look to . . . **LOFTUS**
Engineering Corporation
1 Gateway Center, Pittsburgh, Pa.
140 S. Dearborn St., Chicago, Ill.

57.144A

Effect of Fatigue Cracks on Static Strength

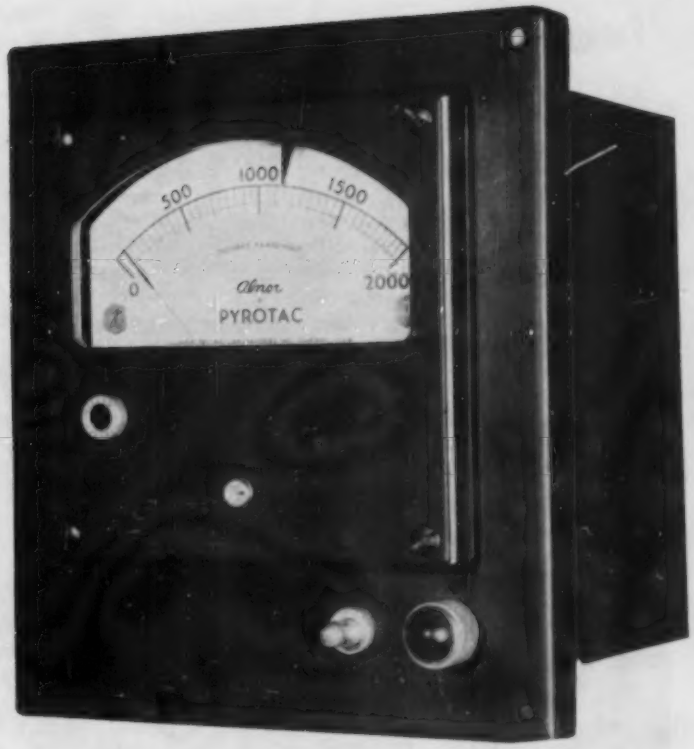
Digest of "Static Strength of Aluminum Alloy Specimens Containing Fatigue Cracks", by Arthur J. McEvily, Jr., Walter Illg and Herbert F. Hardrath, N.A.C.A. Technical Note 3816, October 1956, 54 p.

THE LITERATURE on the fatigue of metals may soon exceed that on corrosion or machinability, and in common with such information offers little more than hope.

Much time has been devoted to the massing of test data on fatigue of metals often with a suitable statistical discount, but there has been a recent tendency to explore the type and history of the crack, its formation and propagation. Most workers agree that the initial crack forms slowly and subsequently either extends instantaneously (A. A. Wells, Aeronautical Research Council, British Welding Research Association, March 1955) or on the contrary propagates slowly until failure approaches (A. K. Read, Report

PYROTAC





Automatic protection against temperature damage

Just as a fuse protects electrical circuits against overloads, the Alnor Pyrotac automatically protects furnaces, kilns and other heating equipment against damage due to excessive temperatures.

This low-cost, easily installed instrument can be added to any automatic or manually controlled equipment and give continuous protection...safeguard your investment in equipment, controls and material in process.

Highest Alnor quality throughout, the Pyrotac features Alnico magnet, double air-gap movement that is standard in all Alnor pyrometers...laboratory precision...industrial ruggedness which assures top reliability.

Write today for complete details on the Pyrotac, available in eight scale ranges from 0-600° F. and 0-3000° F. Ask for Bulletin 2002. Illinois Testing Laboratories, Inc., Room 523, 420 North LaSalle St., Chicago 10, Illinois.



ALNOR PRECISION INSTRUMENTS
FOR EVERY INDUSTRY

Fatigue Cracks . . .

A.R.L.MET.5, Department of Supply, Aeronautical Research Laboratories, Australia, July 1954).

In this N.A.C.A. report on the remaining strength of a cracked part there is a council of despair that "since fatigue cracks are practically inevitable, the designer and operator require information regarding the remaining strength in parts containing such cracks." In a commendable way the authors seek their information from a wide range of aeronautical alloys of aluminum by testing specimens of 2024-T 4 and 7075-T 6 in the form of sheet from 2¼ in. to 35 in. wide, and rolled and extruded bar ⅝ in. thick and 2 or 4 in. wide. Types of stress concentration to start cracks were simulated with notches, holes and tangs.

In order to assess the remaining strength in a part which contained a fatigue crack, the tensile strength of a test piece with stress raiser but no crack was determined and compared with the tensile strength of a similar test piece which had been tested in fatigue to produce a crack of controlled length.

The length of the crack was measured or indeed predetermined by the use of crack detector wires of fine annealed copper wire (0.002 in. diameter) which fractured when a crack imparted a tensile effect and so operated an electrical relay to stop the test. In order to offset the effect of eccentric loading caused by the presence of a fatigue crack on one side, a fine cut of equal length was made on the opposite side.

To give the data from their tests a general rather than isolated value, the authors planned both material and method of testing. They then analyzed the results so that they conformed to accepted ideas of the effects of stress concentration on strength. In such a mathematical adventure several assumptions were necessary: The loss of strength of the notched and cracked section would be decided by the radius at the root of the crack and the Neuber constant for the material. They offer good reasons for assuming that each of these values can be assessed as 0.0036 and using these values the strength of all configurations tested compared favorably with experimental results. Such good agreement is claimed between theory and experiment that it is suggested that once the length of a fatigue crack is measured in a part of known dimensions then the formula can be used to calculate the remaining tensile strength in the part.

The definite conclusion is that for all these alloys and forms a small fatigue crack causes an initially large decrease in strength. The decrease is greater for 7075 than for 2024 but different forms and shapes have common properties for the same material.

Testing conditions and data vary so much that for detailed information the paper must be consulted but a general impression may be gained from the fact that for 2024 sheet, 30% of the tensile strength is lost when the cracked area is about 5%, and for 7075 sheet there is a similar loss of strength when the cracked area is only 2½%.

Only tensile strength is recorded in the tests. There is no reference to the effect of fatigue cracks on yield stress (0.2% offset).

The authors have the distinction of obtaining some predictable data from tests on fatigue. The report should supply to designers and operators the information that structures built of these materials are no longer airworthy after the first appearance of a fatigue crack.

JOSIAH W. JONES



NEW FROM GENERAL ELECTRIC . . .



52% MORE USABLE PANEL SPACE

GENERAL ELECTRIC'S NEW PYROMETER SAVES SPACE WITH PRINTED CIRCUITS AND MINIATURE COMPONENTS

A new pyrometer that fulfills industrial heat treating requirements of close reproducible control at low cost is now available from General Electric.

THE SMALLER SIZE of the new HP-30 Series Pyrometer means that valuable panel space can be conserved. The size reduction of the instrument was made possible through use of printed circuits, high strength magnet material, and miniature components.

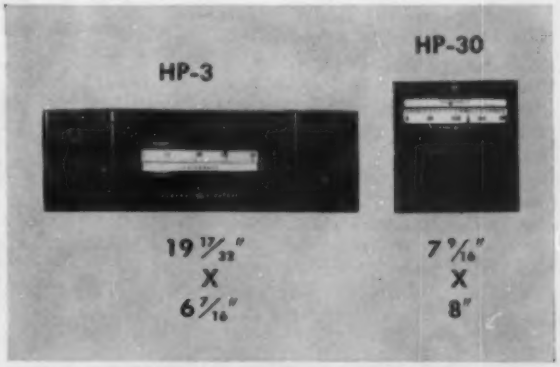
AN EXCLUSIVE FEATURE of General Electric's new pyrometer is automatic lead length compensation. The HP-30 offers lead length compensation up to 25 ohms in low ranges and 90 ohms in higher ranges.

HIGH ACCURACY and control sensitivity are maintained at levels associated with General Electric's HP-3 Pyrometer. The new instrument features ±.5% accuracy and .1% to .5% sensitivity adjustment.

EASY CONNECTIONS are possible with the HP-30 because it features knockouts on the top and side of the controller case. Electrical connections may be made to the front or back of a printed circuit board.

FLEXIBILITY of the new pyrometer allows flush or surface mounting, interchangeable control forms, and range changes that can be made in the field. In addition to six basic control forms, special variations to solve specific control problems are available on request.

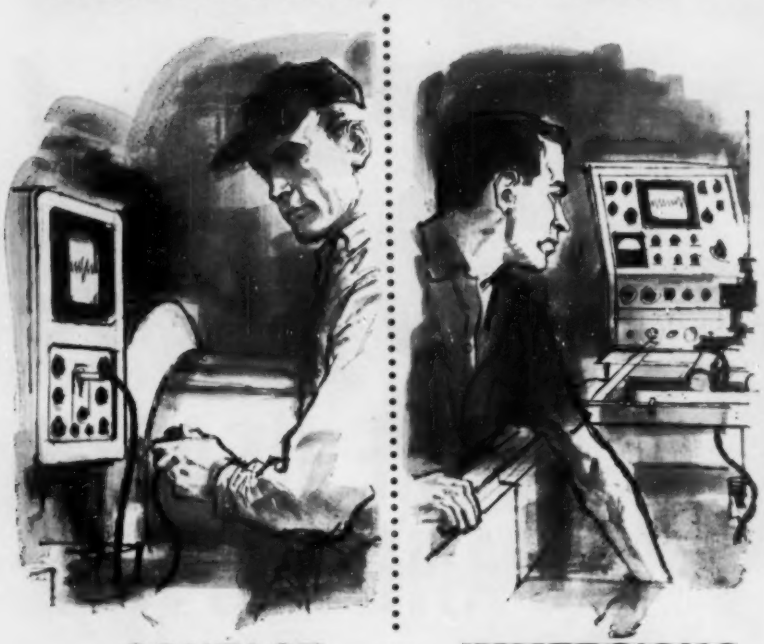
For further information, write to Section 587-8, General Electric Company, Schenectady 5, N. Y., or contact your nearest General Electric Apparatus Sales Office.



COSTLY PANEL SPACE can be saved with the new HP-30—companion to the widely accepted HP-3. Both General Electric instruments feature high accuracy and close reproducible control.

GENERAL ELECTRIC

ULTRASONIC TESTING–



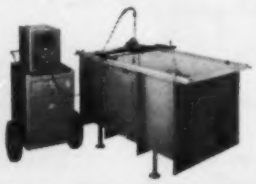
CONTACT or IMMERSION?

Either way, you're served best by the Sperry Reflectoscope

Both ultrasonic immersion and contact testing serve flawless purposes... the type to use is the one that serves your operation most effectively. The *equipment* to use to inspect your material or product for internal flaws is something we know a lot about.

The Sperry Ultrasonic Reflectoscope is admirably suited to *either* type inspection whether "tank" or "touch"... it can be used for one or the other with equally efficient results. Thus, you're not limited to one kind of testing. With the same basic equipment you could perform both immersion and contact testing if your operation required it. Or, whenever it was necessary, you could switch from one type of testing to the other. The Sperry Reflectoscope's "dual adaptability" makes it easy.

In manufacturing the Sperry Reflectoscope for both immersion and contact testing, we have acquired considerable experience in determining which type of testing is best suited to a given manufacturing operation. Should you require any assistance in this direction, we'll be only too glad to help you.



Complete Immersion Testing Systems, available at low cost, ready to use in the production line and laboratory. Call or write for specifications and descriptive literature.

To keep posted on latest developments in the profitable use of ultrasonic inspection, send for your free copy of our Ultrasonic Inspection News Letter. Write to:

Sperry

509 Shelter Rock Road Danbury, Connecticut

sperry products INC.

FIRST IN ULTRASONIC INSPECTION

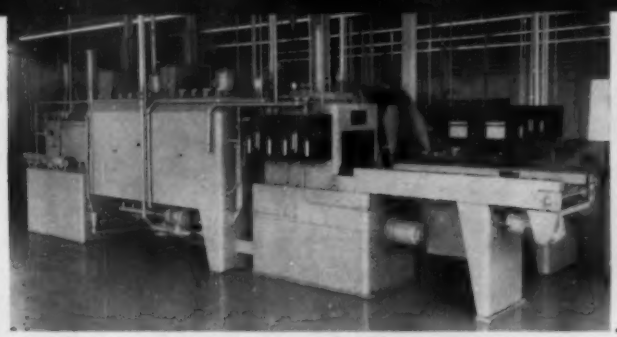
Pressure Die Casting in Vertical Hydraulic Press

Digest of "Pressure Die Casting of Steel," by P. N. Bidulya, I. I. Bobrov and K. N. Smirnova, *Liteinoye Proizvodstvo*, No. 7, July 1956, p. 1-4; translated and condensed in *Engineers Digest*, Vol. 18, January 1957, p. 23-24.

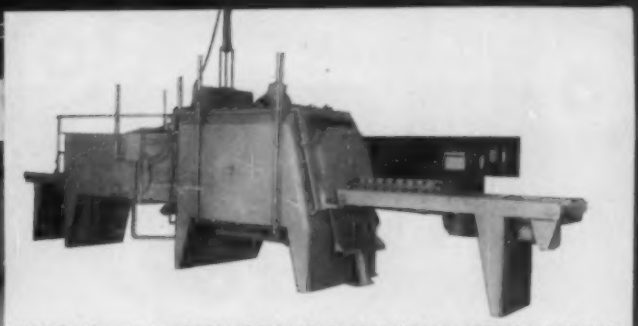
RUSSIAN INVESTIGATORS have engaged in attempts to cast steel under pressure in metal dies since 1943. The early trials, with pressures approximating 350 psi., produced parts with defects and porosity, characteristic of castings. Since 1949 the studies have been continued using higher pressures.

Dies for pressure die casting of steel differ in both design and composition from those used for hot stamping. On an experimental basis, 0.2% carbon steel dies performed better than alloy steel dies. This tentative conclusion has not been checked by production-scale runs. Secondly, the vertical clearance between the moving parts of the die must be very small. Otherwise the liquid metal flows into and freezes in the crevices, thus interfering with opening the die. Furthermore, the press must allow pressure to be maintained on the die until the casting has solidified.

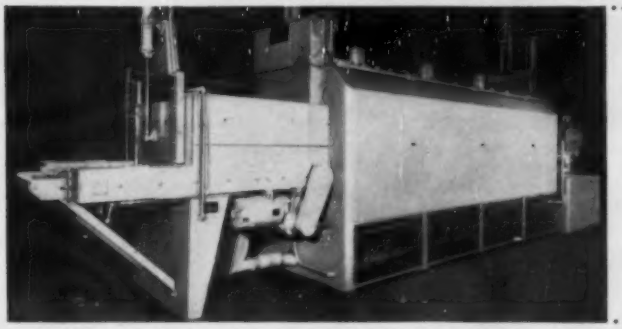
After many experiments an arrangement considered suitable for pressure die casting was developed. The metal dies are mounted in a vertical hydraulic press. The lower die forms the cavity into which the proper amount of steel is poured. A spring-loaded ejector pin is mounted in the lower die. The upper die or punch produces the shape of the upper half of the component. Holes about 0.008 in. in diameter are drilled in the punch to allow gases to escape. The lower die is surrounded by a metal-retaining ring; the upper die carries a separator ring. When the ram of the press lowers the punch, the two rings touch and move down against springs as the punch penetrates into the liquid metal. At this stage of the cycle, the whole die constitutes an enclosed vessel. As compression continues the metal fills the voids in the mold and assumes its shape. After a short dwelling time, the ram is retracted, pulling up successively the punch, the separator ring



100% forced convection "straight-through" controlled atmosphere heat treating unit. Typical applications: carburizing, light case carbo-nitriding, neutral hardening, and marquenching. Available in 8 standard sizes from 150 to 2500 lbs. per hr. Ideally suited for automatic production lines.



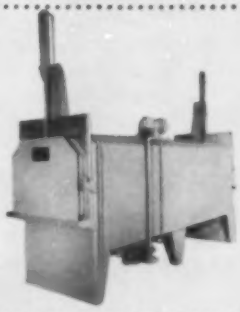
This "straight-through" furnace is for applications calling for controlled atmosphere cooling. These units have two-zone, water-jacketed, cooling chambers with forced convection cooling. Available in sizes to 1000 lbs. per hr. Heating is 100% forced convection with alloyed ceramic heating tubes.



Ipsen standard "pusher" furnace . . . multi-zone, controlled atmosphere furnace for carburizing, carbo-nitriding, and general heat treating. Has atmosphere purge vestibule sealed to charging end . . . oil quench enclosure at discharge end. Capacities from 400 to 4000 lbs. per hr.



Ipsen gas-fired washer for use with Ipsen automatic heat treating units. Drying available—rinsing optional. Available in four sizes—automatic or semi-automatic operation.



Designed for bright drawing and similar applications, this atmosphere tempering unit is available for capacities from 200 to 2000 lbs. per hr.

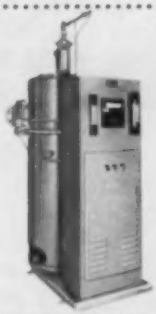
Ipsen OFFERS A COMPLETE LINE OF STANDARD CONTROLLED ATMOSPHERE FURNACES AND ACCESSORIES

Ipsen now offers America's most complete line of controlled atmosphere heat treating equipment . . . in *standard* designs, sizes, and types. Your furnace can be built immediately . . . no waiting while it's being engineered, because it's already engineered!

Standard Ipsen controlled atmosphere furnaces are available in more than 70 different sizes and types . . . from 4000 lbs. per hour controlled atmosphere units . . . to small laboratory furnaces.

Ipsen also offers a full line of standard, already engineered, semi-automatic loading and unloading equipment . . . dew point and carbon potential controllers . . . atmosphere generators . . . washers and related equipment.

Pictured on this page are a few of the many standard units offered by Ipsen . . . descriptive literature available upon request.



Endothermic controlled atmosphere generator. Ipsen also makes exothermic generators; ammonia dissociators. 11 sizes—250 to 2500 cu. ft. per hr. Gas-fired or electric.



Ipsen "Carbotronik" (left) automatically controls carbon potential of furnace atmosphere. "Dewtronik" (right) automatically controls atmosphere dew point.



Semi-automatic loading and unloading equipment is available for single Ipsen heat treating units. With wheels and suitable track, single loaders and unloaders may serve a battery of furnaces.

AUTOMATIC Ipsen HEAT TREATING UNITS

IPSEN INDUSTRIES, INC. • 723 SOUTH MAIN STREET • ROCKFORD, ILLINOIS

Die Casting . . .

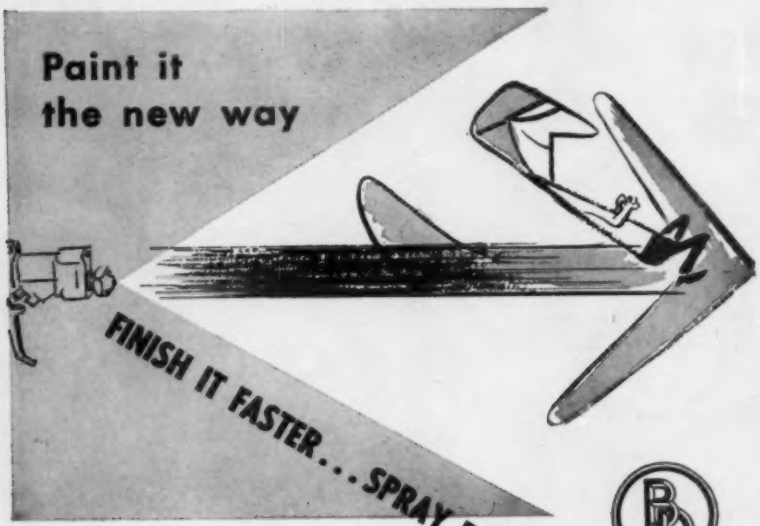
and then the metal retaining ring. Then the casting is ejected and the operation is complete.

Using dies with these characteristics, the investigators established that several factors in the process are of particular importance. First is the requirement that the pressure exceed 7000 psi. based on the area of the working surfaces of the die. Otherwise the castings do not develop maximum density. Also, it is desirable to limit the length of time of pressure application to that required for the primary stage of crystallization of the casting. To insure a good surface finish it is recommended that the die be heated to 400° F. and that a suitable pouring temperature be used.

These procedures were used in producing a variety of experimental pressure die castings. These included cylinders 2.2 in. diameter by 0.4 to 3.0 in. long; rectangular plates up to 65 lb. in weight; rollers, gears and wheels. A dwell time of 20 sec. was found necessary to allow sufficiently complete solidification of a hub weighing 45 lb. With shorter holding times the incompletely frozen casting separated or split when the punch was raised. A 3.3-lb. gear blank was formed satisfactorily using a dwell time of 12 sec.

The castings were evaluated by surface finish, density and mechanical property measurements. The authors report that the pressure die castings had tensile properties equal to or better than wrought steels of the same composition. The microstructure was found to be extremely fine grained and free of porosity. The experiments also indicated that the density of the castings increased with pressure up to 7000 psi. but that higher pressures conferred no benefits. The authors were able to produce finished castings weighing up to 95% of the weight of the liquid steel. They also concluded that direct labor charges were considerably smaller for making wheels by pressure die casting than by conventional methods.

F. W. BOULGER



There's something new and better in spray painting. You can now eliminate as much as 50% in paint loss due to overspray. Eliminate waste, increase production and lower costs with new Airless Spray Painting. See how the Airless process works to save you materials, time and operating costs. You must see how it works . . . BE SURE TO ASK FOR A DEMONSTRATION.

Booth 220
39th NATIONAL METAL SHOW
Nov. 4-8—Chicago Ill.



BEDE PRODUCTS CORPORATION
HOT SPRAY AND AIRLESS SPRAY COATING EQUIPMENT
Jackson St., Dept. 1 YUkon 8-4473 Amherst, Ohio
In Canada: 864 Pope Ave., Toronto, Ontario

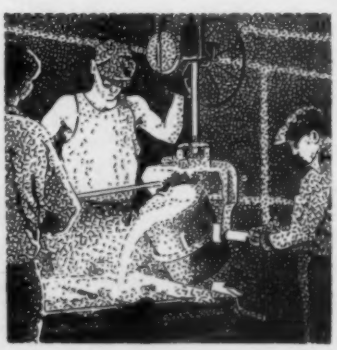
Effect of Vibration on Casting Quality

Digest of "The Effect of Vibration on the Mechanical Properties of H. R. Crown Max and Nimonic C. 75", by J. Jagaciak and J. W. Jones, Report No. 91, College of Aeronautics, Cranfield, England, Sept. 1955, 26 p.

THE AUTHORS investigated a method of production which would reduce the cost, time and defects involved in the manufacture of gas turbine blades for aircraft. The castings were vibrated during the solidification period in order to overcome nonuniformity of the cast structure. It was anticipated that the choice of a suitable casting technique would reduce machining to a minimum, and vibrating would give the blades the desired strength.

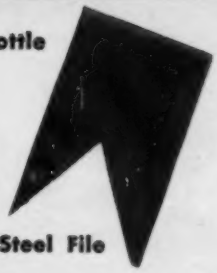
Hinchliff and Jones's test on the effect of vibrating the casting during the solidification period showed improvement of casting by this method.

(*Continued on p.* 194)

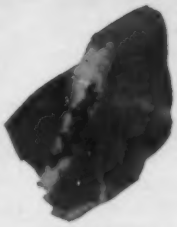


Intricate Cutting Operations Accomplished Quickly and Perfectly


Glass Bottle


Steel File


Porcelain Tubing


Geological Specimens


Metallurgical Specimens

CUTTING-OFF MACHINE

Cuts Metals, Glass, Stone, Quartz, Plastics

Cuts flat materials or cylinders up to 3 inches in depths or diameter.



Special Features Include Miter Gage

MITER GAGE—Cuts of any angle can be made by a simple manipulation of this gage. Its large, convenient scale provides accurate settings.

FOOT-OPERATED ELECTRIC SWITCH — Connected to current by means of BX cable.

WATER PUMP — Fitted with individual motor drive and replaceable impeller. Pumps water from the sump to the cutting wheel.

SPRAY HEADS—Play steady stream of water on the cutting wheel to keep it cool. The water then returns to the sump.

ADJUSTABLE STOP — Used for cutting pieces to exact duplicate lengths.

Write for **BULLETIN 2237— J**

Cat. No. 5-2416, Cutting-Off Machine, 115 volt, 60 cycle, single phase, 1½ h.p. motor, size 25 x 25 x 48 in. high....**$673**

Other models available for 230 and 440 volts.

AMINCO

AMERICAN INSTRUMENT COMPANY, INC.

Silver Spring, Maryland

In Metropolitan Washington, D. C.

Vibrated Castings . . .

Frequency of vibration was the most important factor involved. This has been confirmed by later tests.

A small 3-lb. capacity electric arc furnace, which is relatively inexpensive and durable, and a vibrating table having a large range of frequencies, amplitudes and loads, were built.

Tests were carried out on H.R. Crown Max, consisting of 23% Cr, 11.5 Ni, 3 W, 0.2 C, 1.6 Si, 0.4 Mn, balance Fe.

The charge was melted and the metal held until its temperature dropped to 2910° F. Then the melt was poured into the already vibrating shell mold, producing a wedge-shaped casting with no curvatures (simulating the average shape of a modern turbine blade). While some castings were not of satisfactory quality because the furnace's spout never heated above 750° F., and thus cooled the metal when poured, the majority exhibited superior properties. A shell mold was used because of its smoothness and precision.

By experimentation, a range of frequencies and amplitudes was found which caused maximum improvement of mechanical properties. Tensile strength, elongation, shrinkage, and 0.1% proof stress were at peak values at 4000 vibrations per min. and an amplitude of 2.0 mm. The impact resistance was greatest at approximately 5500 vibrations per min. and 0.9 mm. amplitude. The Vickers hardness average was highest at 6000 vibrations per min. Grain size arrangement was found to be more uniform because of vibration, and the characteristic large dendrites of the static casting disappeared.

Vibration improved mechanical properties by more than 15%. The coring effect was reduced and the grain size of the matrix was smaller, apparently because diffusion was promoted. Porosity was reduced, inclusions were distributed more finely and uniformly, and the density of the metal increased. Possibly the structure was brought nearer equilibrium conditions.

Tests of higher frequencies were made on Nimonic C.75 (19 to 21% Cr, 2.0 max. Fe, 1.0 max. Mg, 0.40 max. Al, 0.50 max. Cu, 0.015 max. S, 0.08 to 0.15 C, 0.30 to 0.80 Si, 0.25 Ti, balance Ni), since it had been found by a previous investigator that properties of steel rose, fell to normal, then rose again infinitely during these tests. The range of frequencies was 0 to 10,000 vibrations per sec. (vps. — note unit change from minute to second).

Apparatus used was an electromagnetic vibrator (very expensive and not too durable), and a furnace similar in size and shape to that used for the other chromium-nickel alloy, but improved and modified. (It took only 1 to 1½ hr. for the melt to reach the desired pouring temperature of 2785° F., as against 4 hr. previously.)

The casting method was comparable to that used before, except that oxidation had to be accounted for and adjustments made to counteract it (additions of Ni-Ti or Fe-Ti and Mg). Above 100 vps. the amplitude varied a negligible amount, and so the frequency was considered the only variable. Under 100 vps., however, the amplitude was an important factor.

Improvement of mechanical properties increased up to 80 vps., decreased to 1000 vps., and increased again from 5000 to 10,000 vps. The most beneficial frequency was found to be 75 to 85 vps.

Summarizing, it is believed that vibration, by introducing mixing

5 Basic Reasons why
MARVEL HACK SAWS
CUT-OFF MORE ACCURATELY...



The consistently accurate performance of MARVEL Heavy Duty Hack Saws is no accident. MARVEL engineers knew, many years ago, that to produce and maintain accurate cutting-off, a hack saw must be designed and built like a fine machine tool.

Some of the basic design principles built into the modern MARVEL Hack Sawing System that makes it the most accurate cutting-off method you can use are:

1. V-Way Design...Greater Rigidity

Upright and Saddle are precision machined and fitted to form a rigid, integral unit capable of withstanding any cutting load with no deflection or side movement.

2. Anti-Friction Bearing Construction

Anti-friction ball or roller bearings are used at all load carrying points. Even the strongly braced saw frame reciprocates on heavy duty, fully enclosed preloaded ball bearings which provide permanent, frictionless rigidity and true-running, straight line cutting strokes.

3. Minimum Blade Frame Reach

Close-coupled design and crank lever action of MARVEL Saws keeps the saw frame and blade reach very short in relation to the vertical V-ways on which the unit is mounted. This insures optimum rigidity, even under the most severe operating conditions.

4. Positive Relief Blade Lift

On the return stroke, positive relief lift raises the blade to provide proper and "cushioned" lead-in on the next cutting stroke. This prolongs blade sharpness, life and accuracy.

5. Rigid Cutting Tool

Cutting-off accuracy requires a rigidity held, relatively short cutting tool. MARVEL Unbreakable High-Speed-Edge Hack Saw Blades, which combine a narrow high speed steel cutting edge permanently welded to a tough alloy steel body, can be tensioned from 200% to 300% more taut than ordinary blades. This provides a most rigid cutting edge.

Write for the MARVEL Catalog and the complete story on MARVEL METAL CUTTING SAWS



PS-1305

MARVEL Metal Cutting SAWS
Better Machines-Better Blades

ARMSTRONG-BLUM MFG. CO.
5700 W. BLOOMINGDALE AVE., CHICAGO 39, ILL.



ALLOY 815-E: A new iron-chromium-aluminum alloy developed especially for use on precision resistor applications. Possesses high resistivity and low temperature coefficient of resistance, plus high strength, excellent ductility, and stability over a wide temperature range.

CHROMEL-C: A 60-16 nickel-chromium-iron alloy widely used in small heating appliances and cold resistors where high resistances are required within limited space. Its stability and uniformity minimize design variables, permit more efficient production of better units at lower cost.

CHROMEL-ALUMEL: The most accurate and most durable base metal thermocouple alloys ever developed. Made exclusively by Hoskins, they are the accepted standards for controlling heat treating operations up to 2300°F. and for measuring temperatures of jet aircraft engines.

ALLOY 46: A gas-free nickel-iron alloy developed especially for use as a terminal material for power resistor units. It is readily "wetted" by enamel to produce a good bond, and its coefficient of expansion is very similar to that of enamels used for such applications.

CHROMEL-D: A time proven low nickel heating element alloy for controlled atmosphere furnace applications. Highly resistant to sulphur attack and preferential intergranular oxidation, it gives long-life service in the critical temperature range between 1500° and 1800°F.

Hoskins

Custom-Quality

ALLOYS

Wire, ribbon, rod and strip for electrical resistance, thermo-electric and mechanical-purpose applications

When it comes to developing and producing custom quality alloys for electrical resistance, thermo-electric, and specialized mechanical purpose applications, you'll find that Hoskins has what it takes to meet your most critical requirements. Complete metallurgical research and development facilities, for one thing. Modern melting and processing equipment, for another. More important, though, is an abundance of human talent . . . people who have the experience, the know-how, and a sincere desire to deliver exactly what you want when and where you want it. *Try them and see!*



Life in a Vacuum—The special vacuum atmosphere life-test equipment shown above was designed and built by Hoskins for use in developing new heating element alloys which will give improved performance and dependable, long-life service in vacuum atmosphere heat treating equipment.

HOSKINS MANUFACTURING COMPANY

4445 Lawton Avenue • Detroit 8, Michigan

Now available to help you



INDUSTRY'S MOST COMPLETE RESISTANCE WELDING APPLICATION RESEARCH FACILITIES

In response to industry's rapidly growing interest in resistance welding, the facilities of the Sciaky Research Division have been made available for contract research in the application of resistance welding.

These facilities include an experienced engineering staff, a complete range of the most advanced resistance welding machines including the largest spot welder in the world and a laboratory equipped for metallography, chemistry, electronics, photography and testing as applied to resistance welding.

Typical projects include: Coordination of design and production for resistance welding; research on the weldability of new metals; investigation of weldability and pilot run of new product; research to develop data for roll spot welding heavy gauges of aluminum.

If you have a fastening requirement, here is the place to determine objectively the feasibility of resistance welding. Send an outline of your problems and ask for the 20-page Research Division brochure. Sciaky Bros., Inc., 4940 W. 67th St., Chicago 38, Ill., POrtsmouth 7-5600.



The Sciaky Research Division is housed in this modern 15,000 sq. ft. building devoted exclusively to research in the application of resistance welding.

... SCIAKY ...

Helps Put Profit Into Manufacturing

Vibrated Castings . . .

effects, produces a more uniform structure by promoting more uniform temperature and chemical composition. This, in turn, eliminates defects in the grain boundary.

Two different alloys reacted similarily to microstructural changes, confirming the improvement of the mechanical properties and the higher quality of the product. It is important that the vibrations be held within the subsonic range and that there is a maximum rate of vibration. After this critical value is passed benefits diminish.

It could be concluded that certain frequencies improve the quality and properties of castings markedly. This effect can be explained on the basis of increased nucleation which produced more uniform and smaller grains than are obtained by conventional casting methods. An increase in density is also a contributory factor.

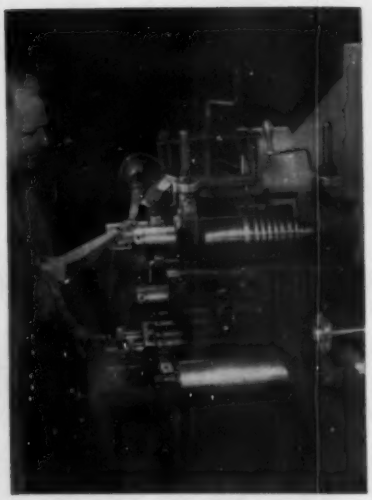
HANS HEINE

Rapid Heating of Forgings

Digest of "Rapid Heating of Small Forgings," by J. E. Russell, *Metal Treatment and Drop Forging*, Vol. 23, July 1956, p. 251-256.

THE ECONOMIC advantages of heating forging billets rapidly are obvious so far as savings in scaling, fuel consumption and furnace times are concerned. In the absence of precise information on the subject, however, most forging plants base their heating schedules on time-honored customs. Many such schedules involve unnecessarily slow heating rates and excessive soaking times. This article, by J. E. Russell of the English Steel Corp., Ltd., reviews information published on this subject during the past five years.

Recent work on heating schedules and soaking times was stimulated by a 1952 publication of E. Terlecki, a Polish investigator. Terlecki showed that the time required for heating cold forgings to 2200° F. could be halved by operating the furnace at 2460° F. instead of 2200° F. The marked saving in heating time results from the fact that the rate of



YODER SLITTERS Supply Varied Strip Widths for Tinnerman *Speed Nuts*®

Tinnerman Products, Inc., Cleveland, Ohio, produces more than 10,000 different shapes and sizes of "SPEED NUT" brand fasteners for industry . . . many of them to special specifications.

To do this, Tinnerman uses slit steel strands ranging in width from ⅛" to 7½". To carry an inventory of the many strip widths required to meet normal and unusual demands would be almost impossible.

Tinnerman overcomes these inventory and supply problems by doing their own slitting on two Yoder slitters. This enables them to supply the plant with any strip size required from a relatively small inventory of 6" and 9" width purchased coils. In slitting narrow strands, such as these from small coils, a Yoder slitter may be profitable on a production as low as 25 tons per month.

Here is a fine example of how a small investment in Yoder slitting equipment greatly simplifies and speeds production while effecting important operating economies.

The saving made in time alone, reflects in better customer service through faster completion and delivery of finished products.

If your steel strip or sheet slitting requirements are as low as 100 tons per month or even less, a medium size Yoder slitter can be a very profitable investment for you. The Yoder line includes units of every size and capacity . . . of the most advanced engineering design. Send for the Yoder Slitter Book —a comprehensive text on the mechanics and economics of slitters and slitting line operation, with time studies, cost analyses and other valuable data. Write to:

THE YODER COMPANY

5395 Walworth Avenue • Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING ROTARY SLITTING LINES



HOUGHTON
Liquid Salt Baths

YOU'LL SEE FAST, UNIFORM HEAT TREATING EVERY TIME

You can depend on Houghton salts for the uniform results you want—every time—batch after batch.

To get the exact salt you need—no matter how tough the assignment—call the Houghton Man. He'll take your requirements to Houghton's team of heat treating specialists. They're experienced, and they're backed up by the most complete research facilities in the business.

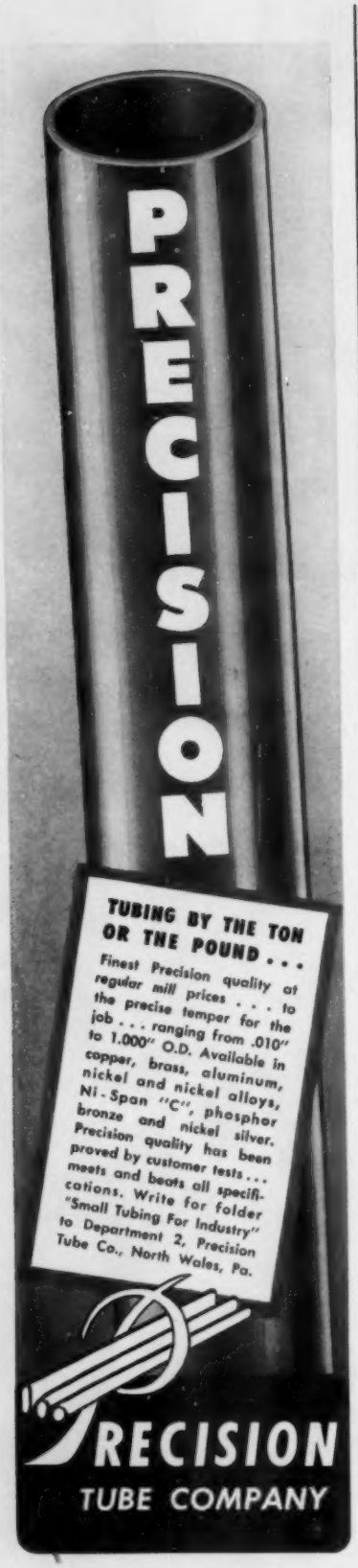
When the Houghton Man makes his recommendation, he's giving you the services of top-flight metallurgists—free of charge. You only pay for heat treating salts—but you're buying insured results.

Whether you need salts for martempering, annealing, quenching, carburizing, nitriding, normalizing or hardening, call Houghton. E. F. Houghton & Co., 303 West Lehigh Ave., Philadelphia 33, Pa.

LIQUID SALT BATHS

. . . products of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO



Heating for Forging . . .

heat absorption by radiation depends on the fourth power of the difference between the absolute temperature of the furnace and of the workpiece.

Cook and Stringer of the British Iron and Steel Research Association checked this conclusion by studies on 8-in. and 10-in. ingots. In their experiments, cold carbon steel ingots were charged to a furnace held at 2460° F. and removed 65 min. later when the surface temperature reached 2280° F. In the case of the 10-in. ingot the center and surface temperatures differed by 160° F. when the ingot was removed from the furnace. Four minutes later, however, the ingot had reached a uniform temperature of about 2200° F. Their work indicates that this heating method is practical when carefully controlled continuous furnaces are available. On the other hand, overheating is likely to occur if temperature measurements are not exact or if furnace operators are careless.

Cook and Stringer also considered the application of rapid heating methods to high speed steel, a material which is more apt to crack when heated too rapidly. They showed that the use of a preheating furnace is desirable. Their schedule for a 6-in. ingot of high speed steel involved placing the cold ingot in a furnace at 1650° F., holding 36 min. until the ingot surface reached 1165° F., then transferring the preheated ingot to a furnace at 2460° F. and holding 16. min. Adaptations of this procedure worked satisfactorily in commercial plants. Russell mentions that 10-in. ingots of 18-4-1 high speed steel were heated in 7⅛ hr. by this practice without any apparent detriment to quality. The normal heating schedule for this product ranged from 40 to 70 hr. Other plant tests showed that heating times as short as 1 hr. for 4½-in. square billets or 1⅛ hr. for 7⅛-in. square billets could be used safely.

Russell considers the question of whether shorter heating times result in better forgeability to be still unsettled. British investigators found no evidence confirming American work (*Metal Progress*, February 1957, p. 150) indicating that shorter heating times improve forgeability. Russell quotes data obtained

STRAITS TIN REPORT

New developments in the production, marketing and uses of tin

MALAYAN TIN BUREAU

Malaya's tin industry is now in a stronger position than that of any other country. Although there has been a decrease in the output of the European-managed dredges, the production of Chinese gravel pump mines has increased in compensation. Malaya's total production of tin-in-concentrates in 1956 was the best for any postwar year —62,295 long tons.

★ ★ ★

The Government of the State of Selangor in the Federation of Malaya recently decided to permit the development of a rich new tin-mining area of about 10,000 acres in the Kuala Selangor district.

★ ★ ★

Tin and tin-zinc solders are most commonly used in the electrical industry for small aluminum-copper connections. Tin-zinc base solders are also finding favorable acceptance for heater cores and engine radiators.

★ ★ ★

A weldable high-strength ternary alloy (92½% titanium, 5% aluminum, 2½% tin), which has become commercially available in sheets, plates, bars and billets, is finding widening use in aircraft manufacture, especially in jet engines and air-frames.

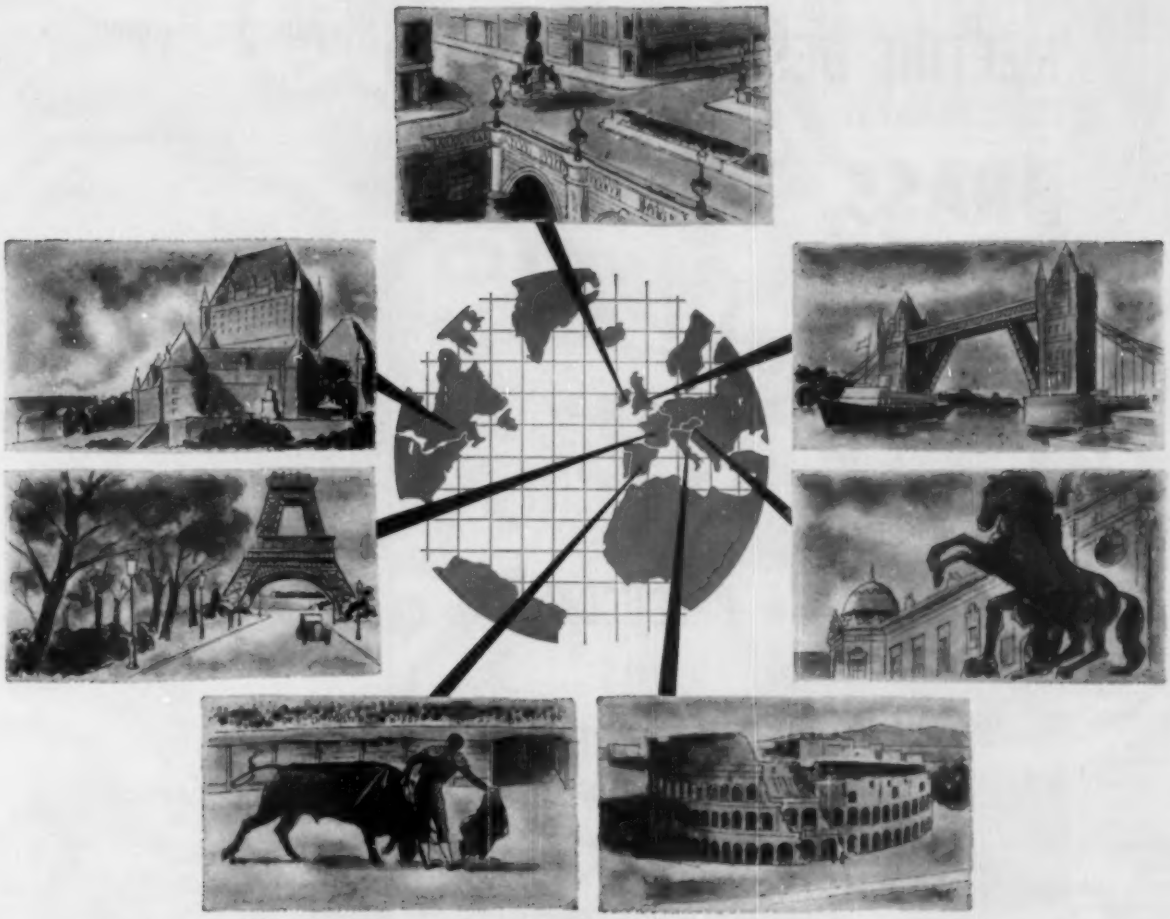
★ ★ ★

In recent tests by the Tin Research Institute two organotin compounds, triethyltin hydroxide and tributyltin acetate, showed great promise in preserving manila and sisal ropes immersed in seawater. Organotin compounds are already being used by industry for stabilizing PVC plastics and chlorinated rubber paints, preventing decomposition of synthetic chlorinated insulating oils, treatment of worms and larvae in poultry and cattle, preventing mould growth on decorators' paints, and slime control in paper manufacture. That's quite a list, and it's still growing steadily.



Ask us to send you TIN NEWS, a monthly letter. It will keep you posted on tin supply, prices, new uses and applications.

The Malayan Tin Bureau
Dept. 25J, 1028 Connecticut Ave., Washington 6, D.C.



Here, too, we make Nichrome*

Perhaps you didn't know that the world-famous alloy Nichrome is produced not only in The United States, but also in 6 Driver-Harris plants in England, Ireland, France, Italy, Austria, Spain, and in Canada by The B. Greening Wire Company. Also, Nichrome is a registered trade-mark in 55 nations.

At first, fifty-odd years ago, we manufactured electrical resistance alloys for furnace elements and domestic heating appliances only. Today we produce 132 different high nickel alloys in many different forms and in hundreds of sizes, for almost every kind of domestic and industrial application—of which Nichrome is the most illustrious.

Whenever you buy Nichrome, you are assured of the unsurpassed and unvarying *quality* which has made Nichrome the supreme world standard for electrical-resistance and heat-resistant alloys. This uniformly high quality, which we jealously guard as our most priceless possession, results from the technical excellence, the productive skill, and the quality controls the Driver-Harris craftsmen have gained in over 50 years of experience—and which are maintained with equal rigor in all Driver-Harris plants here and abroad. The result is a continuous benefit to the entire electrical, electronic, and heat-treating industries.

*M. Reg. U. S. Pat. Off.

Nichrome is made only by

Driver-Harris COMPANY HARRISON, NEW JERSEY

Manufacturing plants also in: ENGLAND • CANADA • IRELAND • FRANCE • ITALY • AUSTRIA • SPAIN

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

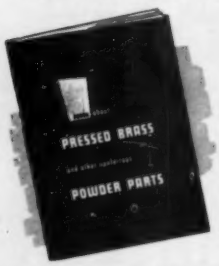
MEETING DESIGN NEEDS
AT LOWER COST
BRASS POWDER
SAVES 92%
IN PRODUCING THIS RECORDER PINION GEAR



This gear was formerly machined from pinion stock, involving turning, drilling, cut-off, milling and wire brushing operations. Total cost was 74¢ per gear. As a brass sintering the gear is now pressed into finished shape and size in one operation—plus the addition of flats to the pinion head—at a cost of 5.8¢ per gear—

A SAVING OF 68¢ IN THE COST OF MANUFACTURE.

How Can BRASS AND NICKEL SILVER POWDER PARTS Meet Your Design Needs?



For detailed information on the design, properties, production and application of brass and other nonferrous powder parts you should have a copy of our manual. It will give you 20 case histories of brass and nickel silver powder structural parts to assist in evaluating this means of production in terms of your particular needs.

SEND FOR YOUR COPY

THE NEW JERSEY ZINC COMPANY
160 Front Street New York 38, N. Y.

Heating for Forging . . .

by I.R.S.I.D. (Institut de Recherches de la Siderurgie), however, confirming American observations that long soaking times are not justifiable from the standpoint of homogenization. Apparently significant amounts of homogenization cannot be produced by thermal treatments less severe than holding 60 to 100 hr. at temperatures in the range of 2200° F.

Russell also briefly discusses resistance heating of forging billets. This method offers advantages because it reduces temperature gradients and thermal stresses. Practical applications of resistance heating are hampered by difficulties associated with producing good electrical contact with the workpiece. Swedish and German steel companies seem to be doing most of the pioneering work on applying resistance heating to forging operations.

F. W. BOULGER

Special Steels for Turbine Generators

Digest of "The Special Steelmaker and Power Generation", by Charles Sykes, Fifth Harold Wright Lecture, Cleveland Scientific and Technical Institution, Middlesbrough, England, Nov. 29, 1956, 35 p.

THIS SUMMARY of the alloy steels used by the English turbine-generator builders is coupled with a good description of some of the metallurgical problems that arise in producing these special steels.

The rapid progress in the design of power generation equipment is illustrated by the following major design advances since 1947:

	1947	1956
Temperature	850° F.	1050° F.
Pressure	600 psi.	2350 psi.
Capacity	30,000 kw.	200,000 kw.
Thermal efficiency	34%	43%

These design requirements intensify the demand for stronger and more reliable alloys for each critical component of these machines as follows:

Steam Piping – The selection of piping materials is based largely upon high-temperature strength properties. Piping is designed on the basis of the allowable plastic flow during the life of a plant and the

(*Continued on p.* 206)

"Excellent Results Have Proved the Value and Versatility of Park's Non-Burning Carburizing Compounds"



Says L. A. Lindberg

President, Lindberg Steel Treating Co.
Chicago – Rochester – St. Louis
Los Angeles

"We have had excellent results with this Non-Burning Carburizing Compound for many years. For example, the pinion gear shaft that Milt Vandenberg is looking over has a heat treat specification of .040-.050" case depth and Rockwell 59-62 "C" Scale hardness.

"We process production quantities of these shafts in a two row, automatically controlled, pusher-type furnace using Park's Non-Burning (grade W) Carburizing Compound. The compound supports the parts during carburizing so that distortion is controlled and straightening operations are minimized. Tooth form and lead angle of the gear remain within the allowable tolerance and case depth is very accurately controlled.

"The value and versatility of this operation for such parts as well as for low-cost production items has been proved to us over the years. We have learned to depend on Park for uniformity and for service!"

Park NON-BURNING CARBURIZING COMPOUND is available in sizes No. 3, 6, and 8, and in two grades: "B" and "W". The latter grade is designed to minimize the possibility of copper migration on copper plated work. All sizes and grades are manufactured by coking a special quality coal in the presence of the energizing chemicals. This process produces a homogeneous compound and insures uniform carburizing activity even though usage reduces the material to pinhead size. Shrinkage rates are low and carburizing activity can be maintained indefinitely with addition ratios of as low as 1 to 10.

NON-BURNING is the quality carburizing compound that is economical to use. In addition to its uniformity and low replenishment requirement, it does not burn after removal from the furnace. NON-BURNING is especially suitable for carburizing alloy steel parts such as gears which are direct quenched or reheated. Send for the free, informative technical bulletin B-1, "Pack Carburizing of Steel in Solid Compounds".

● ● ●

Woodside Rapid Carburizers (Non-Burning—Charcoal-Coke-Specification) ● Park-Kase Liquid Carburizers ● Quenching and Tempering Oils ● Cyanide Mixtures ● Neutral Salt Baths ● High Speed Steel Hardening Salts ● Iso-Thermal Quenching and Tempering Salts ● Protective Coatings (No-Carb—No-Kase—No-Scale—No-Tride) ● Carbon Products (Charcoal-Crushed Coke-Pitch Coke-Lead Pot Carbon) ● Kold Grip Polishing Wheel Cement ● Par-Kem Metal Cleaners ● Cutting and Grinding Compounds (Kem-Cut—Kem-Grind—Blue Ice)

Park

PARK CHEMICAL COMPANY ● **8074 Military Ave. Detroit 4, Mich.**



Here N-A-X FINEGRAIN *steel proves its versatility, forming readily under the deep-drawing operation that pressure cylinder manufacturing requires. For 20-lb. cylinders, .086″* N-A-X FINEGRAIN *blanks, 21¼″ in diameter, become 12″ in diameter and 7½″ in depth after the drawing operation. Steel Cooperage Division produces cylinders up to 425-pound capacity.*



Submerged arc welding operation joins the two cylinder sections together. N-A-X FINEGRAIN *again demonstrates its weldability under any process.*



Here cylinder pressure capacities are tested hydrostatically at 480 lbs. psi, after the fittings have been added. Final burst pressure—1350 lbs. psi.



Finished product on the job. This cylinder, meeting all specifications of I.C.C. code, Section 4BA, contains liquefied petroleum for materials handling truck.

For whatever you make . . .

N-A-X® FINEGRAIN STEEL BUILDS IN STRENGTH WITH LIGHT WEIGHT

A significant example of the strength, formability and weldability of N-A-X FINEGRAIN steel is to be found in the manufacture of liquefied petroleum gas cylinders by Steel Cooperage Division of the Serrick Corporation, Detroit.

These lightweight LP-Gas cylinders must be able to withstand high internal pressures. Therefore, the steel used in their manufacture must have a minimum yield strength of 50,000 pounds per square inch and a tensile strength of 70,000 pounds per square inch, in order to meet the requirements of Section 4BA of the I.C.C. specifications.

On this job, as with so many others, N-A-X FINEGRAIN steel resulted in lighter weight, without sacrifice of strength and safety.

Check these important advantages for your job: N-A-X FINEGRAIN steel, compared with carbon steel, is 50% stronger • has high fatigue life with great toughness • is stable against aging • has greater resistance to abrasion • is readily welded by any process • offers greater paint adhesion • polishes to a high luster at minimum cost. And the physical properties of N-A-X FINEGRAIN are inherent in the "as rolled" condition. N-A-X FINEGRAIN'S resistance to normal atmospheric corrosion is twice that of carbon structural steel. NOTE: Where greater resistance to extreme atmospheric corrosion is an important factor, our N-A-X HIGH-TENSILE is recommended.

For whatever you make, from pressure cylinders to tractors, with N-A-X HIGH-STRENGTH steels you can design longer life, and/or less weight, and economy, into your products. Let us show you how.

N-A-X
HIGH-STRENGTH STEELS

N-A-X Alloy Division, Dept. E-5

GREAT LAKES STEEL CORPORATION

Detroit 29, Michigan • Division of

NATIONAL STEEL CORPORATION

N-A-X Alloy Div., Dept. E-5
Great Lakes Steel Corp., Detroit 29, Michigan

☐ Please send me technical data on N-A-X FINEGRAIN steel.
☐ Please have your representative contact me.

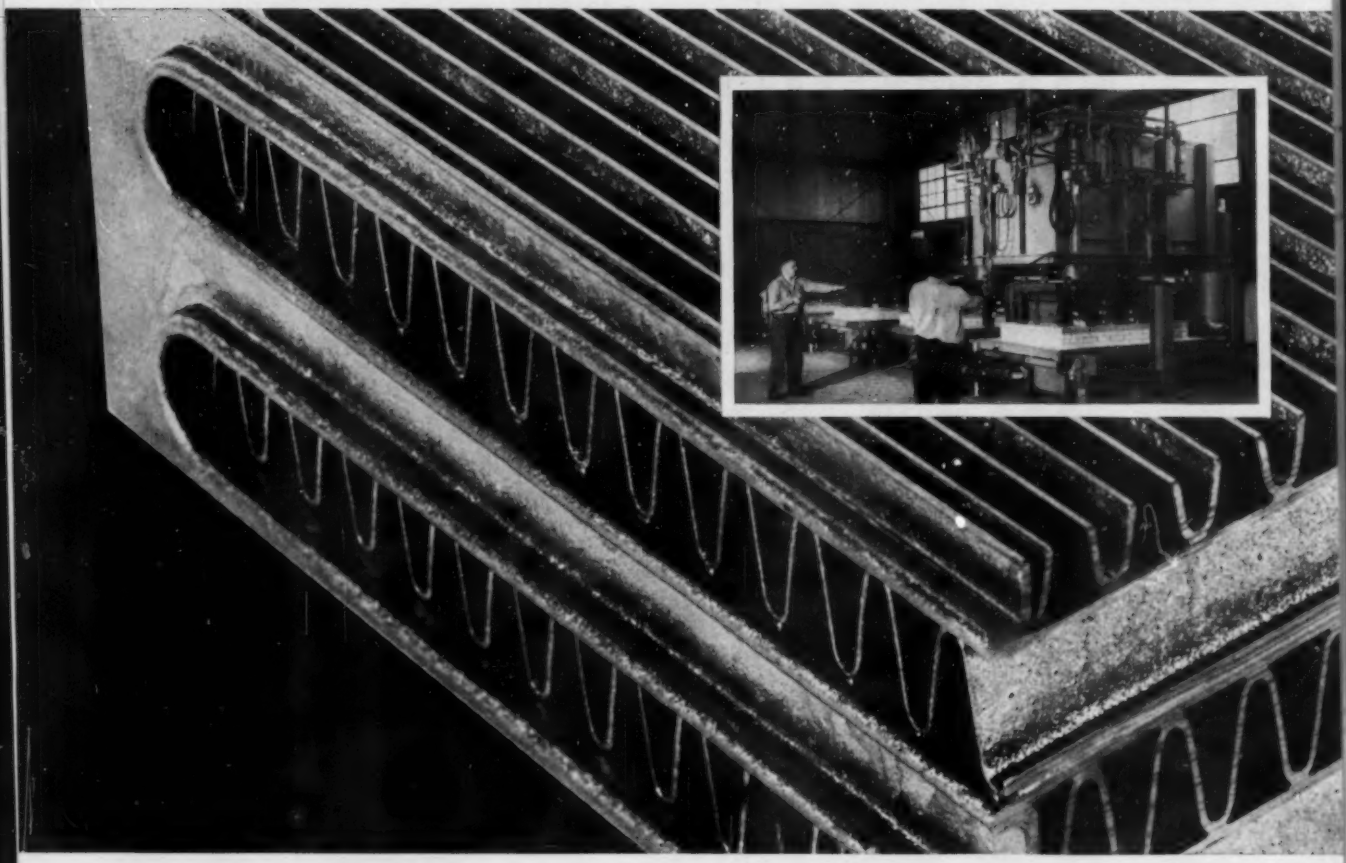
Name_____ Title_____

Company_____

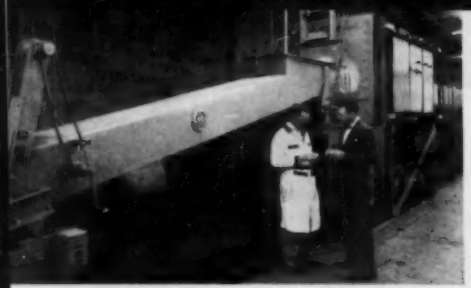
Street_____

City_____ Zone____ State_____

General Electric engineers complex brazing problem



OTHER TOUGH BRAZING PROBLEMS SOLVED BY GENERAL ELECTRIC . . .



CONTINUOUS BRIGHT BRAZING of stainless-steel assemblies without flux, and bright annealing and hardening of stainless parts, make this General Electric hump-type furnace with alloy muffle a versatile tool at Specialty Steel Treating, Inc., Van Dyke, Michigan. Hump construction of this General Electric furnace saves atmosphere gas and provides bright, oxide-free work.





REDUCED COSTS in assembly of 105 mm recoilless steel cartridge cases were the result of furnace brazing at Skagit Steel and Iron Works, Sedro Woolley, Washington. Use of a General Electric

FURNACE BRAZING'S GOLDEN ANNIVERSARY

PIONEERED AND DEVELOPED BY G.E.

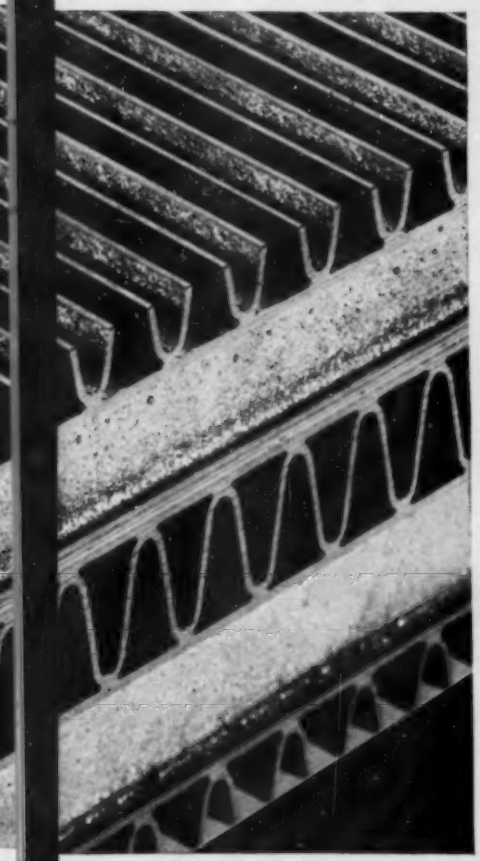


1907
A scientist in General Electric's laboratory found that, in hydrogen, molten copper wets iron and makes strong bonds.

1912
Tungsten contacts for automobile ignition systems were successfully joined to steel fingers by furnace brazing.



help Griscom-Russell solve on Plate-Fin heat exchanger



Uniform brazing achieved with new Gas-Fired Bell Furnace from General Electric

Here's a complex heat exchanger just developed by Griscom-Russell Company, Massillon, Ohio. It is constructed of mild steel, coated and furnace brazed with a nickel base alloy for high temperature gas-to-gas applications. These applications include gas turbine regenerators and furnace or kiln air preheaters for recovery of stack gas heat.

PROPER SELECTION: Because they needed high production capacity, rigid quality control and good operating economy, Griscom-Russell and General Electric's industrial heating specialists considered several different furnace set-ups to accomplish the braze. The solution was a gas-fired rectangular bell furnace consisting of the heating bell and four bases and retorts—for heating, holding, and cooling. This solution gives Griscom-Russell the needed effect of semi-continuous processing with the added advantage of individual heat control for each valuable load.

PLACING THE HEAT: To get uniform brazes throughout the work, both under- and over-firing were used. A special piping and baffling arrangement was designed to preheat and distribute the protective atmosphere gas, dissociated ammonia. Assuring temperature uniformity and conserving heat, the new furnace exhausts are at the bases rather than through a vent at the top of the furnace.

THEY LIKE IT: Demonstrating that the many problems were solved satisfactorily, Griscom-Russell says, "Using the General Electric gas-fired furnace, our assemblies can be uniformly brazed and completely coated with corrosion resistant alloy in just one operation".

THOROUGH PLANNING: Griscom-Russell's representative goes on to say "General Electric gave us a lot of helpful advice and excellent service from early in the planning stages of the process development right through the delivery and installation of the shop-assembled furnace in our plant".

HEAT PROCESS PROBLEMS: Just ask for the services of your local General Electric Apparatus Salesman. Or send us the coupon for literature.

GENERAL ELECTRIC



roller hearth brazing furnace eliminates costly press work, four or more process anneals, machining and perforating of the tube after it is formed. For more information send coupon at right.

FREE PROCESS BULLETINS

Section C721-9
General Electric Company
Schenectady 5, New York

Please send me free bulletins checked below.

MODERN HEAT PROCESSING BULLETINS

- ☐ Furnace and Induction Brazing, GEA-5889
- ☐ Protective Atmospheres, GEA-5907

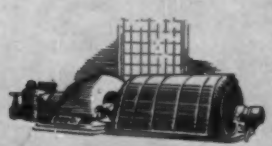
TECHNICAL BULLETINS

- ☐ How and Where to Use Furnace Brazing, GEA-3193
- ☐ Electric Furnace Brazing, GER-106
- ☐ Furnace Brazing of Machine Parts, GER-339
- ☐ How to Braze Stainless Steels, GER-1331

NAME.....

COMPANY.....

ADDRESS.....

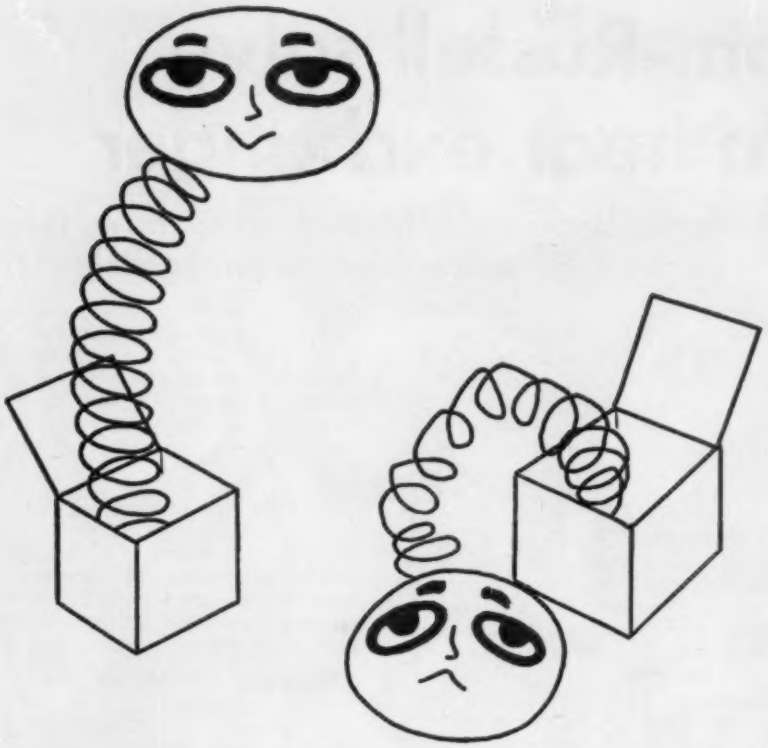


1919
Turbine-diaphragm nozzle rings were successfully copper brazed in production by G-E three-stage furnace.

1927
The General Electric "Monitor-top" refrigerator included several copper brazed sub assemblies.



1957
In defense, stainless steel assemblies for air frames, jet engines, guided missiles and nuclear equipment are now G-E furnace brazed to obtain high strength at high service temperatures, light weight and high quality.



Some Springs Have It...Some Don't

The difference in spring performance is most often due to the wire or strip used... and there's more to a spring material than just the "bounce". How about other requirements, such as corrosion resistance, high temperature properties, fatigue resistance and low temperature toughness.

When your springs need any of these properties your best bet is one of our alloy spring materials.

Riverside-Alloy Metal Division can supply you with spring wire and strip in stainless steels, nickel alloys, phosphor bronze and beryllium copper.

Learn more about our spring materials. Write to Riverside-Alloy Metal Division, H. K. Porter Company, Inc., Riverside, N. J.

Send today for our free handbooks



ALLOY METAL WIRE
Prospect Park, Pa.

RIVERSIDE METAL
Riverside, N.J.

PRENTISS WIRE MILLS
Holyoke, Mass.

H. K. PORTER COMPANY, INC.
RIVERSIDE-ALLOY METAL DIVISION

Turbine Steels . . .

allowable plastic deformation may be large compared to that permitted for other parts such as bolting. Note that improved strength permits the use of thinner-walled piping and this in turn simplifies the associated problems of forming, welding and thermal stresses. The following grades of steel are used for the various steam inlet temperatures:

Steam Temperatures	Type of Steel
850° F.	Carbon
950	0.5% Mo 1% Cr, 0.5% Mo
1000	2.25 Cr, 1 Mo
1050	0.5 Cr, 0.5 Mo, 0.25 V

At 1050° F. the use of low-alloy steel begins to be marginal, and some high-pressure stations utilize stabilized austenitic piping.

Turbine Blading – Operating conditions for blading vary considerably throughout the turbine. Inlet blades operate near the maximum steam temperatures and thus creep strength is important. Exit blades, on the other hand, operate just above room temperature and the stresses are much higher due to the longer blade lengths; here, the critical requirements are high strength, good fatigue and corrosion resistance. The 12% Cr stainless steels have a long and satisfactory record as turbine blading and successive modifications have been made to increase the creep strength and, thereby, to extend the upper operating temperatures. The following blading alloys are arranged in the order of increasing creep strength:

Alloy Type	Creep Strength* 900° F.
12% Cr	
12 Cr, 0.5 Mo	975
12 Cr, 0.5 Mo, 0.25 V	1075
12 Cr, 0.5 Mo, 0.25 V, 0.4 Cb	1160

Turbine Rotors – The requirements for turbine rotors vary from the small, high-pressure, high-temperature inlet section of the turbine to the large, low-pressure, low-temperature exhaust section. The rotor forgings are made of different materials suited to varying conditions and temperatures as follows:

*Temperature for 0.1% elongation in 1000 hr. at 10,000 psi.

Low temperature	Carbon steel
Intermediate	Ni-Cr-Mo C-Mo 3% Cr-Mo
High	Cr-Mo-V
Very high	Austenitic

Generator Field Forgings – Creep strength is no longer a critical factor but is replaced by the need for good magnetic permeability. The rapid growth in the size of these machines means that size of these forgings must be continually increased. Fortunately, certain design developments such as direct cooling permit great economies; thus the size of a typical 120-mw. field is only about twice the weight of a 30-mw. field.

To satisfy the demands of turbine-generator builders for these large, critical parts, the steelmakers must solve a number of basic problems.

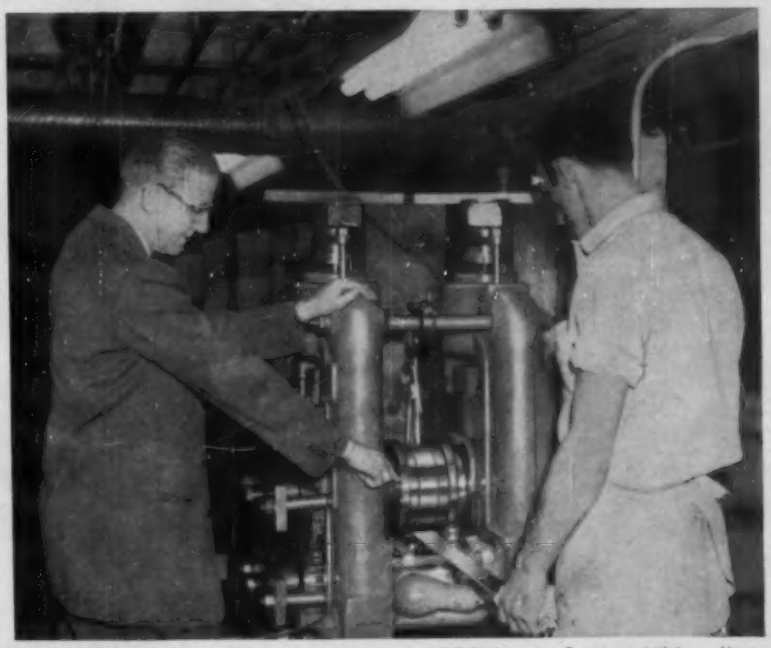
High-Temperature Strength – Obviously, improvements in the creep and rupture properties are the basis of past and future progress in this field. The relationship between composition and creep performance is known only in a general way, since certain elements may exert several effects simultaneously – for example, strengthening the matrix and forming carbides for other precipitate particles.

The addition of chromium to an excellent creep resisting steel greatly increases the size of the precipitate and at the same time causes a sharp loss in creep strength. However, in a different type of 6% Cr steel, the precipitation of a different and much finer phase is associated with the development of excellent creep strength.

Embrittlement – Another basic problem is to produce alloys that will maintain their structure and properties after long exposures to high operating temperatures. Usually these exposures will cause precipitation of new phases, agglomeration of old ones and precipitation at grain boundaries. These and other reactions frequently result in lowered notched toughness, lowered impact energies and higher transition temperatures. In extreme cases, the normal tensile ductilities are also reduced significantly and such steels are not suitable for service irrespective of their excellence in other properties. While the specialty steelmaker has often been criticized

(*Continued on p.* 210)

Proof of Vulcan Tool Steel Superiority



Cold rolling of critical heat resisting alloy stator vanes at D.E. Makepeace Company, Attleboro, Mass.

Vulcan Service PLUS TCM Steel solves tough rolling problem on jet stator vanes

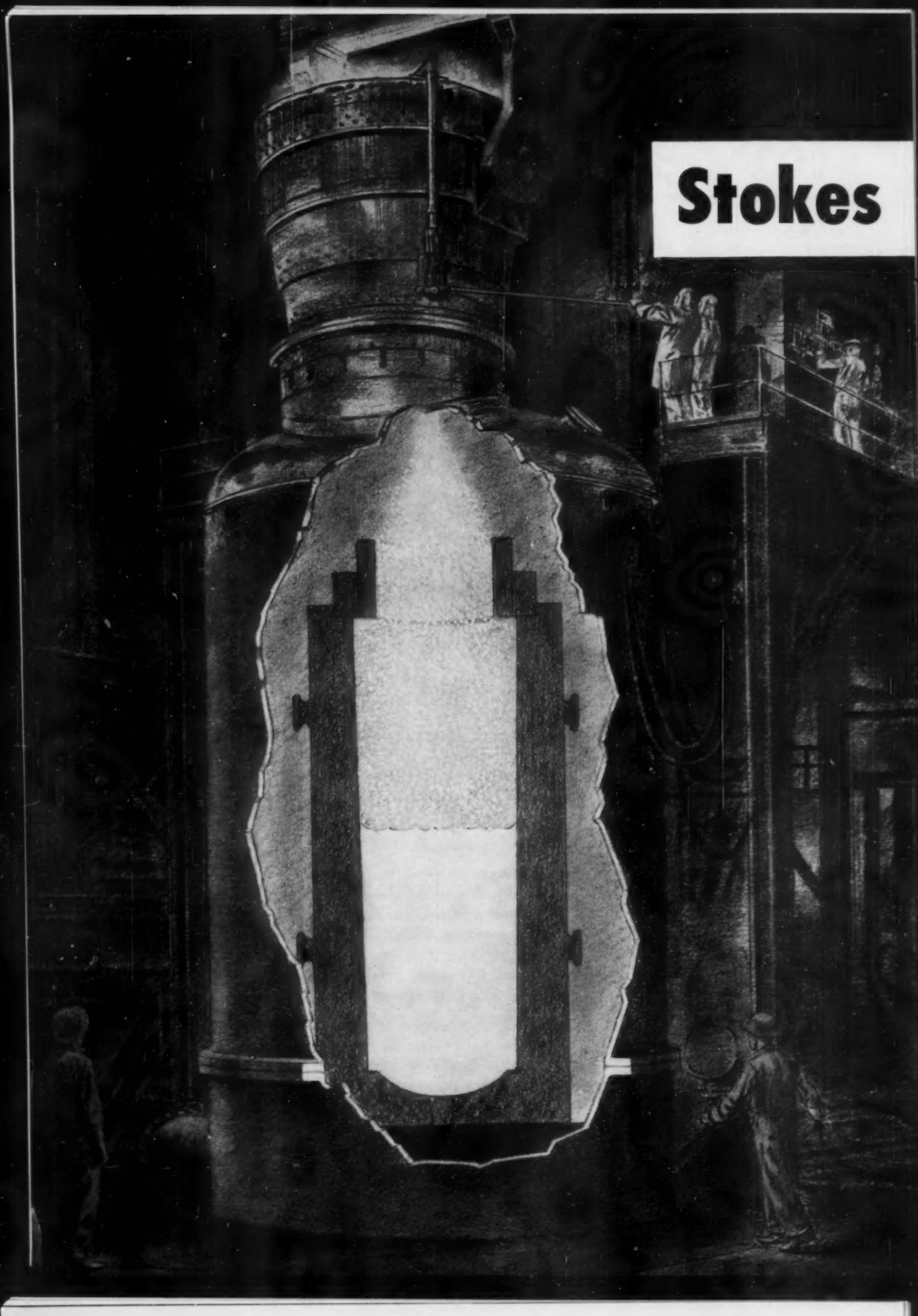
Vulcan sales engineers, working closely with the tool experts of D. E. Makepeace, faced a tough and exacting problem: How to increase the service life of rolls used in cold rolling critical jet engine heat resisting alloy stator vanes.

As a result of joint investigations, design changes were recommended and adopted. The result? Roll life was multiplied.

Vulcan engineers went further. Despite the fact that other grades of tool steel had been tried and found unsatisfactory, Vulcan engineers predicted that *additional* improvements could be made by using Vulcan TCM steel. This recommendation, too, was adopted. The result? The already increased roll life was *trebled*. Net result: substantial savings with increased roll life, less down time and greater productivity.

This same engineering help is available to you without charge. For the name of your nearest Vulcan representative, write, wire or call collect. Vulcan Crucible Steel Division, H. K. Porter Company, Inc., Aliquippa, Pa.

H. K. PORTER COMPANY, INC.
VULCAN CRUCIBLE STEEL DIVISION


Stokes

Vacuum Stream Degassing

...proved production equipment that removes hydrogen from steel, improves basic physical properties

Vacuum stream degassing is a practical method of refinement which improves the physical properties of steel . . . provides a better steel for not only critical machining applications, but for structural and plate products as well. The elimination of hydrogen flaking—failure of worked surfaces to weld together in forging operations—means the elimination of rejects in raw and semi-finished forgings. Ductility of metals can be increased, and soaking pit time reduced up to 70%, depending on ingot size, thereby reducing process time and inventory problems. The equipment is, therefore, a self-amortizing investment.

Vacuum stream degassing can control the hydrogen content of steel to less than 1 ppm by removing gaseous impurities when the metal is in the molten state.

This technique is not only an asset to the steel industries, but may also become a significant factor in the production of non-ferrous metals, especially copper and aluminum.

Stokes offers a completely practical system of stream degassing. As illustrated, the furnace ladle is lowered onto and sealed to a vacuum chamber . . . or, if more suitable the ladle can pour into an intermediate ladle mounted on the chamber. The melt is tapped—flows through a seal and is teemed into the ingot mold within the vacuum chamber. As the molten metal enters the vacuum, it disperses in a spray. Extensive surface area makes the degassing practically instantaneous.

Broad experience in high vacuum processes, and in vacuum furnaces of all types, has provided Stokes with the background and abilities to serve the metal industries. Stokes is the first American supplier to install a major working system for stream degassing—and therefore has extensive design and operational performance data.

Stokes offers—A complete analysis of your specific needs—Complete engineering of a degassing system to meet your requirements, up to 250 tons capacity—Complete fabrication and erection services for turnkey delivery —The advantages of a vast accumulation of process information—and undivided responsibility for performance. Complete Stokes vacuum stream degassing systems are sold without process royalty involvements.

Write for additional information on this and other Stokes vacuum system applications—ask the Stokes Advisory Service for consultation on your job requirements.

Vacuum Equipment Division
F. J. STOKES CORPORATION
5500 Tabor Road, Philadelphia 20, Pa.

STOKES

Turbine Steels . . .

for producing steels with such a great variety of constituents, it should be appreciated that these additional elements are only included because the steelmaker has, so far, found no simpler way of achieving the desired results.

Dimensional Stability – A rather special requirement of the turbine-generator plant is that the turbine and generator rotors run true over a wide range of operating temperatures. For example, a 10-ft. long shaft must not bow more than 0.001 in. at the midpoint because any deflection in excess of this would cause excessive vibration while running. Occasionally this requirement for dimensional stability has caused some difficulty. In one case it was caused by slight variations in the microstructure on opposite sides of the forging. These microstructural differences and the resulting dimensional instabilities were corrected by insuring very uniform heating, holding and cooling conditions during heat treatment.

Size – While many turbine components can be produced using conventional techniques, the critical turbine and generator rotors require very large forgings and their very size greatly complicates the production problems. Freedom from internal stress, uniformity of properties, the development of adequate hardenability, freedom from ingot segregation and shrinkage, and uniformity of temperature during heat treatment and forging become progressively more difficult as size increases.

Design studies for future power plants involve 1150° F. and higher temperatures. This will demand the use of more austenitic components. These alloys will present welding problems during the fabrication of the piping system, particularly in those joints between austenitic and ferritic elements. The more complex 12% Cr martensitic and the highly austenitic steels will find increasing application.

D. G. EBELING

keeping up with **SODIUM**

Sodium handling in the plant

new book describes how

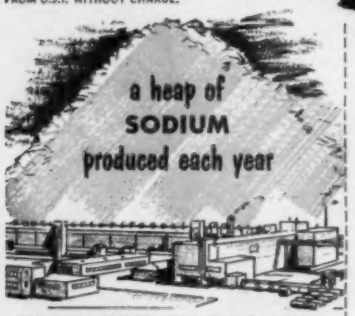
THIS BOOK IS FOR ENGINEERS AND PRODUCTION MEN WORKING IN DESIGN, DEVELOPMENT AND OPERATION OF SODIUM HANDLING EQUIPMENT.

CONTAINS INFORMATION SUCH AS–

- DETAILS OF TYPICAL SODIUM-USING PROCESSES
- DETAILS OF EQUIPMENT INSTALLATION, INSULATION, HEATING, REPAIR
- RECOMMENDATIONS FOR SODIUM PUMPING, METERING, INSTRUMENTATION
- SAFETY IN DESIGN AND OPERATION

FORTY-FOUR PAGES OF DETAILED INFORMATION ON SODIUM HANDLING BASED ON IN-PLANT EXPERIENCE. NO SUBSTITUTE FOR DIRECT U.S.I. TECHNICAL ASSISTANCE, THIS BOOK WILL NEVERTHELESS PROVIDE THE READER WITH A SOLID FOUNDATION IN THE PRINCIPLES AND PRACTICES OF SODIUM ENGINEERING. AVAILABLE FROM U.S.I. WITHOUT CHARGE.





WELL OVER A HUNDRED THOUSAND TONS OF SODIUM ARE USED IN THE UNITED STATES EVERY YEAR. 140 MILLION POUNDS GO INTO TETRAETHYL LEAD; ABOUT 45 MILLION INTO SODIUM CYANIDE; ALMOST AS MUCH INTO FATTY ALCOHOLS; 7 TO 10 MILLION INTO SODIUM PEROXIDE; ABOUT 4 MILLION INTO SODIUM HYDRIDE DESCALING OF STEEL; AND ABOUT 4 MILLION FOR INSECTICIDES, DYES, DRUGS, ALKOXIDE PREPARATION, SPECIALTY CHEMICALS, ATOMIC ENERGY AND A NUMBER OF MISCELLANEOUS USES. AND NOW TITANIUM METAL, "U.S.I. ISOSEBACIC" ACID AND MANY ORGANICS ARE JOINING THE LIST.

U.S.I. TECHNICAL SERVICE HAS BEEN CALLED ON BEFORE OR DURING DESIGN OF ALMOST EVERY NEW SODIUM HANDLING UNIT BUILT DURING THE PAST FEW YEARS. THE SAME SERVICE IS AVAILABLE TO YOU IN ALL PHASES OF YOUR DEVELOPMENT, DESIGN, AND PRODUCTION.

DID YOU KNOW



- THAT MILD STEEL IS SATISFACTORY FOR MOST SODIUM HANDLING EQUIPMENT?
- THAT SODIUM PIPELINES CAN BE CUT AND REWELDED WITHOUT DRAINING?
- THAT SODIUM BRICKS ARE MOLDED IN OPEN AIR?
- THAT MOLTEN SODIUM CAN BE PUMPED AND METERED CONTINUOUSLY?
- THAT THE ATOMIC ENERGY COMMISSION HAS STUDIED OVER 60 CONSTRUCTION MATERIALS FOR SODIUM HANDLING?

RESULTS OF THE A.E.C. STUDIES, ALONG WITH MANY OTHER DETAILS OF SODIUM HANDLING TECHNOLOGY, ARE PRESENTED IN U.S.I.'S NEW BOOK.

ASK FOR NEW U.S.I. SODIUM HANDLING BROCHURE.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corporation
99 Park Avenue, New York 16, N.Y.
Branches in principal cities

Increasing Blast Furnace Output

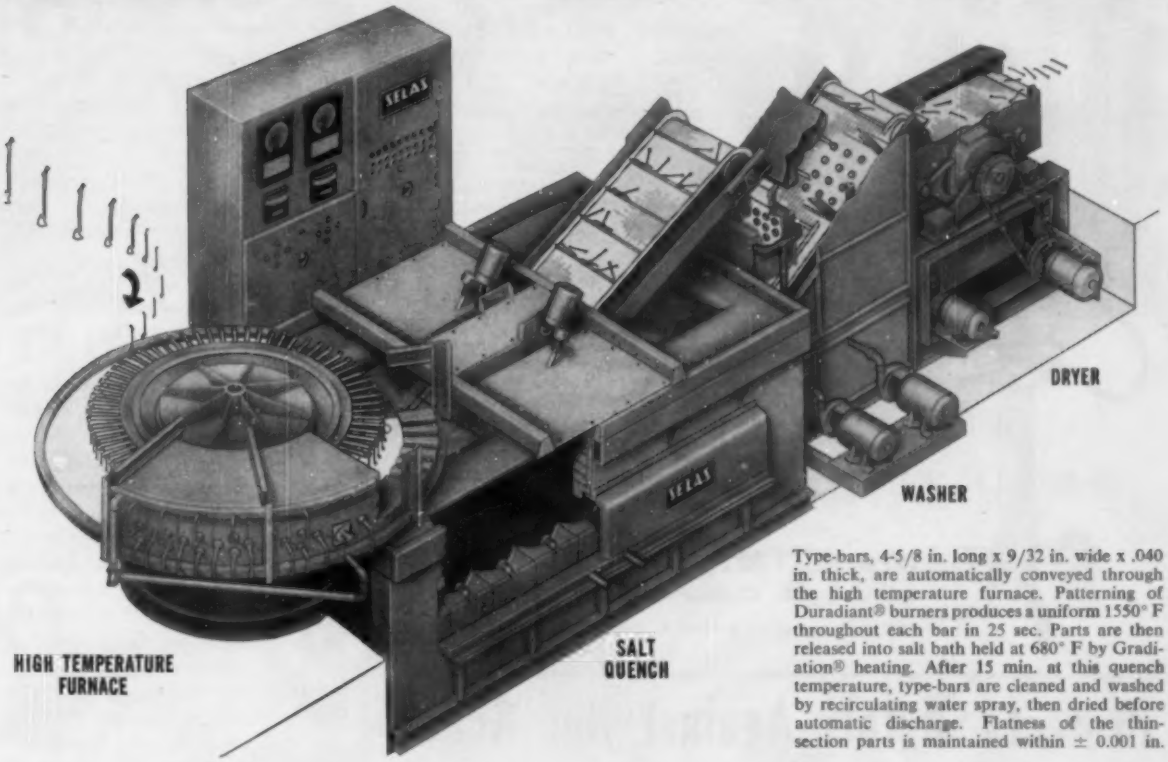
Digest of "More Iron Without More Furnaces", by Charles M. Squarcy and Richard J. Wilson, American Iron and Steel Institute, Regional Meeting, Chicago, Oct. 17, 1956, 26 p.

WELL-KNOWN factors which increase blast furnace output are (*a*) beneficiation of ores, (*b*) better coke from washed coal, (*c*) high top pressure operation, (*d*) introduction of steam in the blast, (*e*) addition of oxygen to blast, (*f*) higher hot blast temperatures.

The application of several of these improvements or combinations of them to the eight blast furnaces at Inland Steel Co. gives concrete information as to the benefits gained. A ten-year period (1947 to 1956) is covered by these test runs.

A reduction in coke ash content from 10.3% in 1947 to 6.3% in 1956 increased the daily output of hot metal from 7450 tons per day to 8600 tons in 1956, while slag volume was reduced from 1110 to 934 lb. Increase in the percentage of sized ore and sinter in the burden from 8.6% in 1947 to 14.8% in 1957 gave higher blowing rates and increased production 23.2% on the larger furnaces. The author does not state whether decreased coal ash was involved and gives no information as to whether the character and quality of iron ore varied much during the periods in which data were collected. The small increase in percent of sinter in the charge does not explain

IBM Reports Labor Savings of 40%



Type-bars, 4-5/8 in. long x 9/32 in. wide x .040 in. thick, are automatically conveyed through the high temperature furnace. Patterning of Duradiant® burners produces a uniform 1550° F throughout each bar in 25 sec. Parts are then released into salt bath held at 680° F by Gradiation® heating. After 15 min. at this quench temperature, type-bars are cleaned and washed by recirculating water spray, then dried before automatic discharge. Flatness of the thin-section parts is maintained within ± 0.001 in.

. . . SELAS automatic heat-treating unit austempers more than 3,000 type-bars per hour

Three men do the work previously performed by five with this integrated Selas heat-processing equipment. When automatic loading, for which the unit was designed, is added, the full production capacity of 5,000 type-bars per hour will be attained and further labor savings effected.

IBM electric typewriters require hard, tough, extremely flat type-bars for dependable performance. These characteristics are produced by heating the steel above the critical temperature, quenching at elevated temperature to permit isothermal transformation to occur. This process—austempering—is not new . . . the coordinated, multi-stage Gradiation heat-treating unit *is* new, offering a fresh approach to complex heat processing.

Cut-away view delineates continuous process cooperatively developed by IBM and Selas engineers. Actual unit, compactly fitted into minimum floor area, was completely built at Selas . . . including panel-mounted combustion and temperature controls.

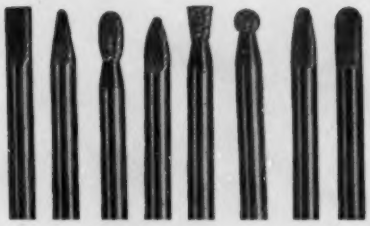
For nearly a year the unit has been austempering steel type-bars at high production rates, at IBM's Kingston, New York, plant, with virtual elimination of rejects. So satisfactory has been the performance that a similar unit, for heat-treating other IBM electric typewriter parts, has been ordered and is now under construction at Selas.

To learn how Selas can help solve your particular heat processing problem also, write Department 39.

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers
DEVELOPMENT • DESIGN • CONSTRUCTION

MARTINDALE



CARBIDE ROTARY BURS

Cut toughest metals, abrasive materials, and metals too hard for ordinary high-speed tools. Precision ground from solid carbide. Each tooth lapped to provide cooler cutting, extremely long life, lower costs. Illustrated are typical shapes available in all sizes from 3/32" to 1" diameter. Complete line of high speed steel rotary burrs and files.



MOTOR-FLEX UNITS

Most versatile general purpose power tools for grinding, burring, buffing, filing and similar production operations. Martindale units have ball bearings throughout, flexible cores made of finest spring steel, and run in rubber-covered non-shrinkable sheaths. Seven models: 24 combinations of shaft speeds and 1/10 to ½ H.P. to meet specific needs. Available in bench, pedestal or overhead suspension types.
Complete line of attachments for all finishing operations.

MARTINDALE ELECTRIC COMPANY

1372 Hird Avenue • Cleveland 7, Ohio

WRITE TODAY FOR **NEW CATALOG** 64 PAGES of maintenance, safety and production equipment

Protects Metals Against Hot Acids, Acid and Sulfurous Fumes, Salt Spray, Steam, Mild Alkalies, Up to 600°F.



Markal "D-A" Coatings will protect metal against any corrosive action. It is an ideal product, for ore sintering plants, plating plants, food plants, lumber kilns, foundries, chemical plants, sewage disposal plants, laundries, heat exchangers . . . many others.

Markal "D-A" Coatings are applied by brush or spray and can be air dried or baked. The Coatings will withstand temperatures up to 600°F.

For free sample write on company letterhead, stating temperature extremes, surface temperature at time of application, and corrosive condition.

Other Markal Coatings are available in a complete range of types for any condition and temperature up to 2200°F. Send for catalog No. MPC. The **Markal Company,** 3118 West Carroll Avenue, Chicago 12, Illinois, telephone SAcramento 2-6085.

Blast Furnace . . .

the much larger increase in output.

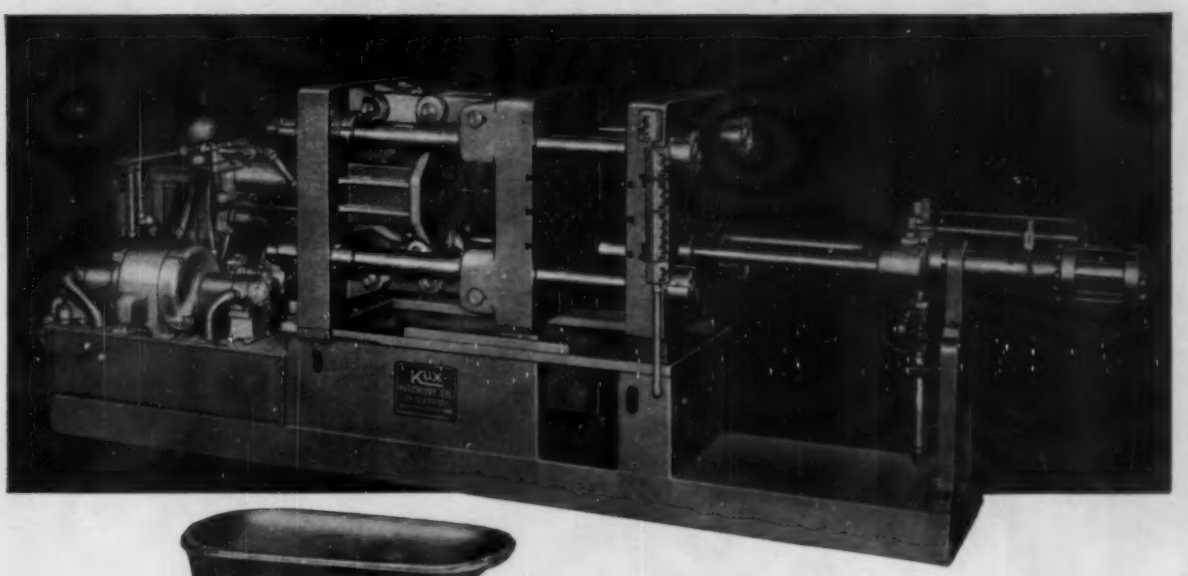
A tabulation of results of higher sinter charges at six different plants shows that a 9 to 18% decrease in coke consumption will result with increases in sinter up to 40%; a production increase of 7 to 20% may also be expected. Improvement in coke consumption and production rate with burdens of over 40% sinter are not so marked. Evidently Inland needs more sintering capacity if their present burden contains under 10% sinter, as shown in this paper.

Other methods of increasing blast furnace output are use of high top pressures (10 to 15 lb.), higher blast temperatures, use of air enriched with oxygen and steam for better control of hearth temperature and maintaining the volume of bosh gas at near normal. Higher pressures permit a greater volume of wind to be blown, giving faster smelting rates. This increased volume is a function of the void space in the charge; raising the amount of screened ore and sinter reduces the fine materials in the charge and thus increases void space.

Oxygen enrichment up to 25% is possible and this increases the driving rate because the coke burns more rapidly. More than 25% oxygen in the blast gives such high hearth temperatures that the bosh refractories are greatly damaged. Many furnace men believe that the best way to increase the driving rate (and thus obtain higher blast temperatures), is to increase stove temperatures.

The author believes the best way to use oxygen enrichment is to add steam to the blast. This permits hearth temperature to be maintained, increases coke combustion by means of the water gas reaction, and gives a larger volume of reducing bosh gas ($CO + H_2$) than when oxygen enrichment is used alone. Calculations indicate that a blast with 25% oxygen plus 3.8% steam will raise the rate of carbon combustion 17.4% over that with normal air blast, while 30% oxygen plus 8.1% steam will increase carbon combustion 34%. Bosh temperature will be lower than for air blast because heat is absorbed in decomposing steam. Higher blast temperatures will com-

(*Continued on p.* 216)





women buy by eye . . . so

ENTERPRISE

chose

KUX

DIE CASTING MACHINES

to get hardware finish quality castings

"Our products are sold primarily to women, who are attracted by two qualities: good looks and a bargain price," writes Mr. W. B. Sheeler of the Enterprise Manufacturing Company of Philadelphia.

"Kux machines give us the beauty of a hardware finish at an amazingly low cost per unit.

"We use them to cast aluminum tops for our *Home Aid* Freezer, and aluminum bases for our *No Clamp Chopper* and our *Shredder-Slicer-Grater*.

"Our engineering department selected the Kux machine primarily through recommendations of other firms using this machine," continues Mr. Sheeler. "The courtesy and service extended by the Kux people, in addition to the features of the multiplier, made our choice a certainty." (The exclusive patented Kux Multiplier increases the ending pressure up to five times the starting pressure, producing the most solid of die castings.)

Possibly your product can be redesigned to use die castings with a resulting increase in sales. Let KUX engineers give you the answer, or write for free illustrated catalog.

MODEL HP 37 ILLUSTRATED

Hydraulically operated die casting machine for production of aluminum casting weighing up to 10 pounds.

KUX MACHINE CO. 6725 NORTH RIDGE AVENUE • CHICAGO 26, ILLINOIS

The floor charging machine at left is loading an ingot into a heating furnace. At right is the control panel with ***ElectroniK*** strip chart program controllers.



ElectroniK program controllers automatically regulate soaking and cooling furnaces. These furnaces are also equipped with Honeywell multiple burner ***Protectoglo*** flame safeguard systems. The control cabinet of one of these systems is shown at upper right.



These *ElectroniK* program controllers automatically regulate the heating furnace time-temperature program. The panel also contains two Brown indicating pressure controllers which regulate furnace draft.

Program your time-temperature cycles...

with *ElectroniK* controllers

A large eastern producer of specialty steels uses Honeywell *ElectroniK* program controllers for automatic control of heating and soaking furnaces. These controllers have the flexibility needed for the variety of work handled—stainless and heat-resisting steels, matched tool and die steels, high nickel alloy steels, and special purpose alloys.

In the press shop, where a hydraulic press reduces ingots for rolling, *ElectroniK* strip chart program controllers automatically regulate four heating furnaces and two soaking furnaces. These instruments are ideal for this type of operation because their control point settings, and heating, soaking and cooling rates are easily changed to meet the time-temperature requirements of various kinds of stock.

Where a process calls for *repetition* of a prescribed time-temperature pattern, *ElectroniK* circular chart cam program controllers are used to advantage. Once the program is cut on the plastic cam, it can be repeated over and over again with consistent accuracy.

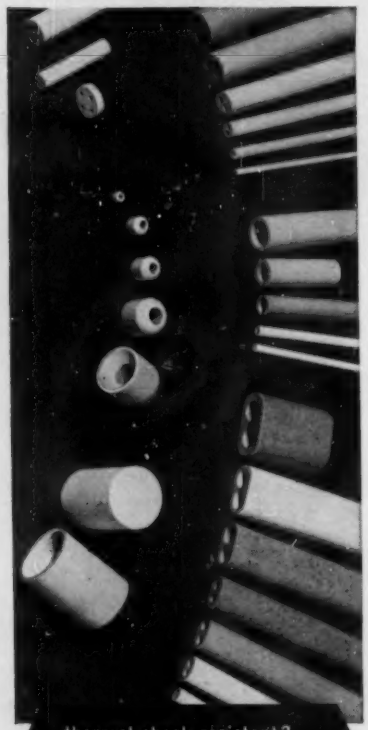
For time-temperature program instrumentation matched to your own particular requirements, call your nearby Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Aves., Phila. 44, Pa.—in Canada, Toronto 17, Ont.

• REFERENCE DATA: Write for Catalog 1531, "*ElectroniK* Controllers."

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

Insulators for Thermocouples



thermal shock resistant?
mechanical strength?
high temperature resistant?

It's SERV-RITE® for any need

One or more of these SERV-RITE thermocouple insulators will take care of your needs. If not, there are many more in Gordon's large stock for quick delivery. If you need something entirely special, it can be made to suit your specific requirements.

In the 50 years that Gordon has been supplying thermocouples and accessories to industry, emphasis has been on uniform top quality, service, and value. And so with insulators for any thermocouple application, SERV-RITE assures you of plus values every time.

Write for full information on SERV-RITE thermocouple insulators.

Ask for Bulletin 300-56

This new 4-page bulletin gives specifications and ordering data on all Gordon standard SERV-RITE thermocouple insulators grouped for easy selection. 8404

CLAUD S. GORDON CO.
Manufacturers • Engineers • Distributors

613 West 30th St., Chicago 16, Ill.
2021 Hamilton Ave., Cleveland 14, Ohio

Blast Furnace . . .

pensate for this and the author believes that the use of these three factors will be of great benefit in increasing output. Also the furnace operator will have much better control of hearth temperature.

E. C. WRIGHT

Particle Size Analysis

Digest of "Particle Size Determination in Powder Metallurgy", by L. A. Phelps, *Metallurgia*, Vol. 54, October 1956, p. 197-200.

THIS paper does not contain any results of original research, but presents an interesting review of the available experimental methods for particle size analysis.

The use of sieves is limited to a practical lower limit of 40μ and obviously no information can be obtained on the shape of the particles. If shape is important, the microscope offers the most convenient answer to the problem, but a difficulty arises in obtaining a representative sample. The method is also long and tedious. The author briefly mentions a modern innovation in which a scanning beam from a television tube runs across a projected field and counts the particles of various sizes. This new technique will certainly intrigue many readers, and it is unfortunate that no reference was given to the original work.

In the subsieve range of particle size, the classical method of sedimentation is still very widely used. The author discusses the various factors which might lead to erroneous interpretation of the results. The shape of the particles is of course of primary importance, since the results of sedimentation experiments are generally interpreted on the basis of Stoke's law which is valid for spherical particles only. The effect of the Reynolds number is also appreciable in some cases.

The turbidometer technique, which is based on the light transmission through a suspension of powder in a liquid is useful for very small particles only, and leads to a measure of the specific surface rather than the particle size.

POL DUWEZ

NEW

Luster-On®

52 POWDER

PROTECTS and BRIGHTENS ZINC at LOWEST COST YET

LUSTER-ON 52 POWDER *is a low, low priced single dip, no-leach conversion coating for zinc plated surfaces.*

LUSTER-ON 52 POWDER was recently developed by The Chemical Corporation for automatic equipment where facilities are not available for added leaching and rinsing.

LUSTER-ON 52 POWDER gives a bright bluish hue; provides lasting corrosion protection against staining, tarnishing and white powder products.

LUSTER-ON 52 POWDER can *now* be used in cases where cost has prohibited use of chromates in the past. For instance, electrical conduit, conduit boxes, screws and builder's hardware, tools, electronic parts, air conditioning parts, automotive parts, cheap toys.

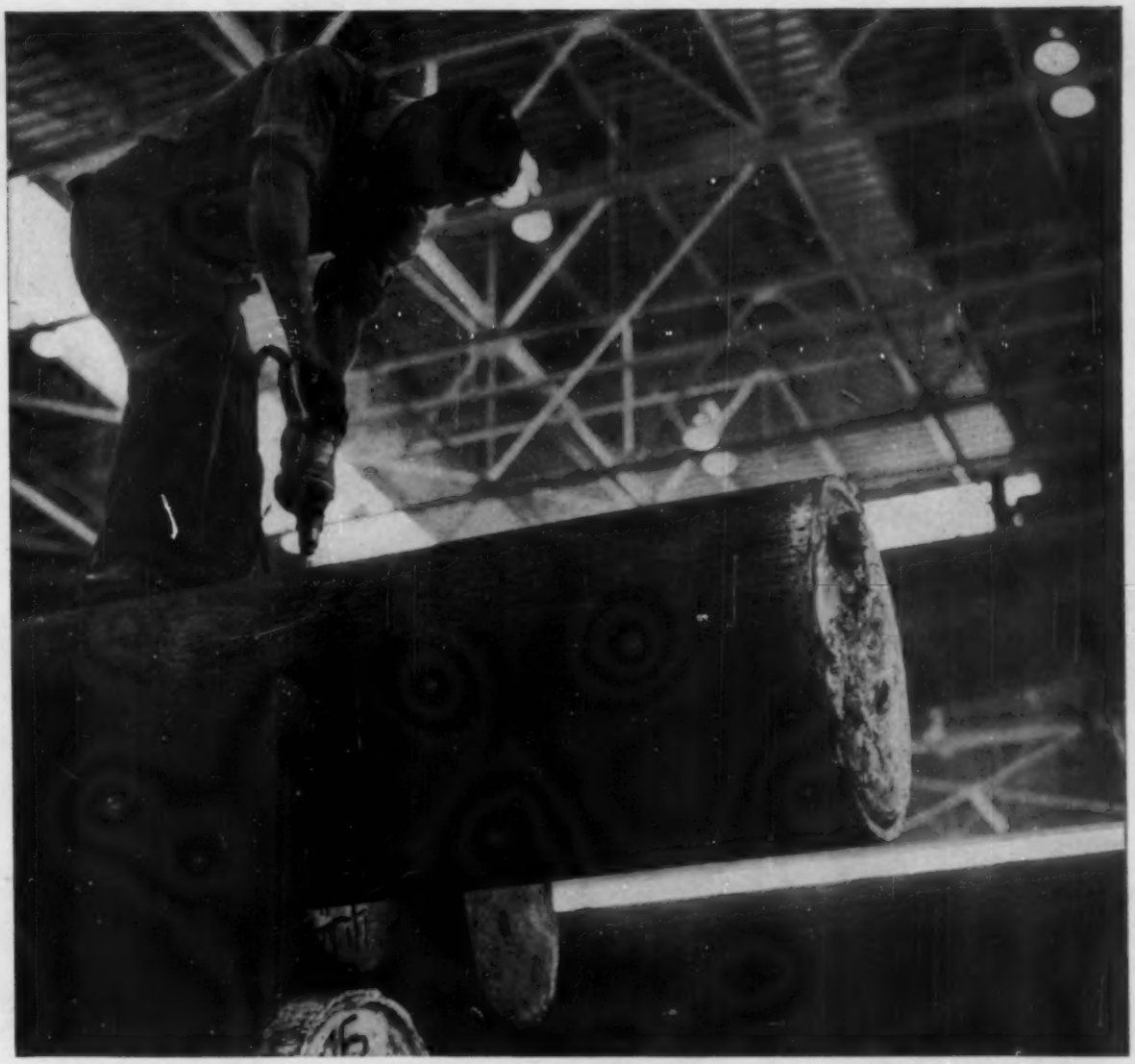
LUSTER-ON 52 POWDER is not only low, low in price, but eliminates expensive handling, space-consuming storage and carboy deposits.

Still available, of course — time-tested Luster-On liquid dips and coatings for all your needs.

Data Sheets and Prices on Request. Send in part for free processing.

West Coast: Crown Chem. & Engr. Los Angeles & San Francisco
Canadian Licensee: Alloycraft Ltd. Montreal

THE Chemical CORPORATION
70 Waltham Avenue, Springfield, Mass.



Kaiser Aluminum ingots being prepared for "homogenizing" in Gas-fired furnaces prior to extrusion into aircraft parts

GAS assures

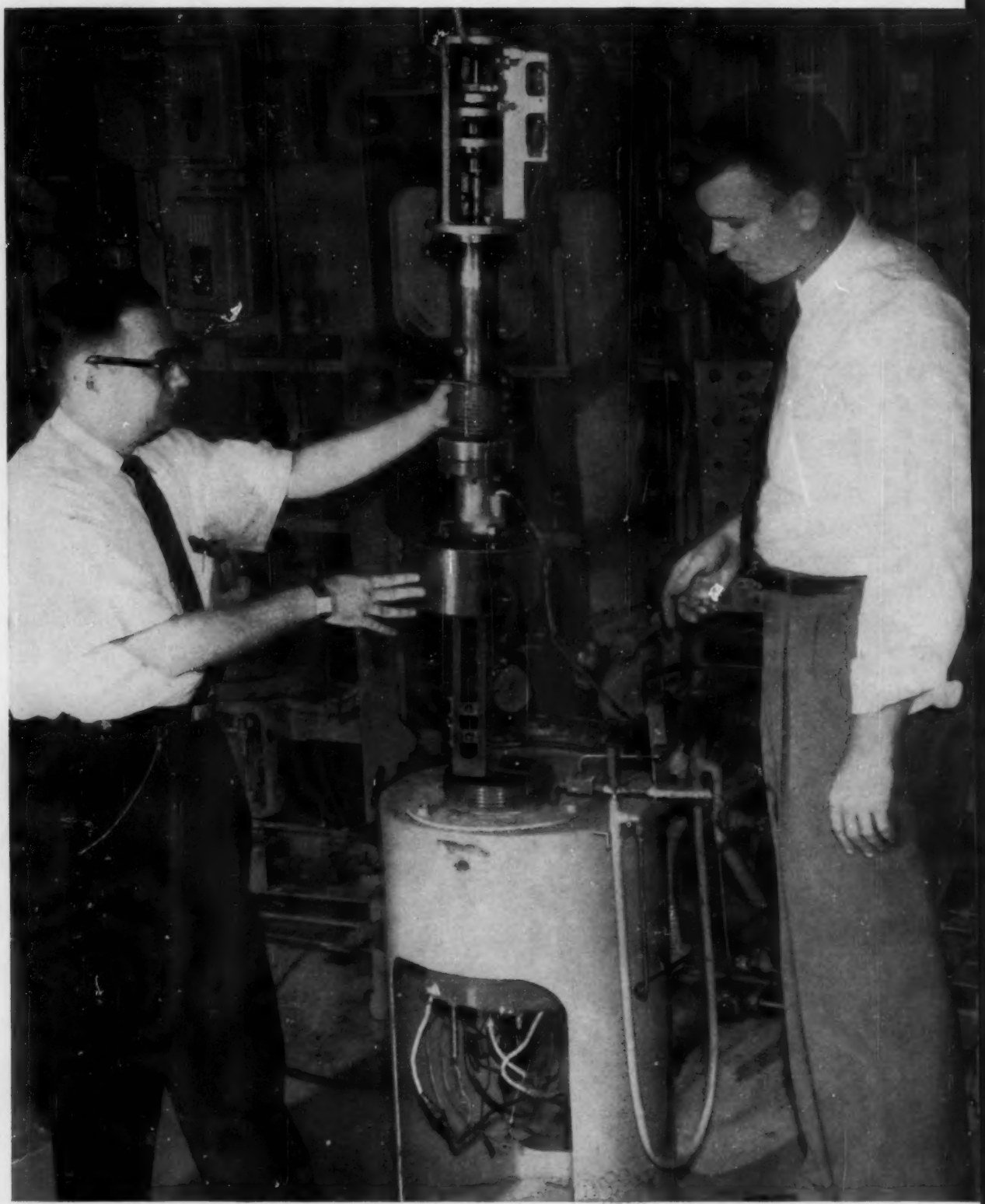
precision alloy extrusions at Kaiser Aluminum

Gas plays a major role in the development of precision quality alloy extrusions for aircraft at the U. S. Air Force Heavy Press Plant operated by Kaiser Aluminum at Halethorpe, Maryland.

With Gas, uniform temperature and controlled atmosphere keep molten aluminum flowing smoothly into casting equipment. The metal is cast into logs about 12 to 26 inches thick and 25 feet long. Gas-fired furnaces heat the logs to 1000° F and hold this temperature about 24 hours to homogenize the metal prior to extrusion. The long logs are cut into 58 inch billets, placed on the press and extruded into various shapes.

Again, Gas is used to heat the extruded shapes in a controlled atmosphere to impart the desired physical qualities in the alloys used. As in the melting process, Gas provides precise temperature control and close control of atmosphere within the furnace.

For information on how Gas can help you in your production operations, call your Gas Company's industrial specialist. He'll be glad to discuss the economies and outstanding results Gas and modern Gas equipment provide. *American Gas Association.*



Dr. Eric Rau and James Alger, Bettis engineers cooperating on different aspects of this program, are discussing details of a preliminary corrosion fatigue test. Note two specimens mounted on a knife edge in the machine. The entire assembly is attached to the head of an autoclave for immersion in water at 600° Fahrenheit. Dr. Rau received his Ph.D. in physical chemistry from New York University in 1955. Mr. Alger obtained his Master's degree in metallurgy from the University of Washington in 1955.

MATERIALS ENGINEERING

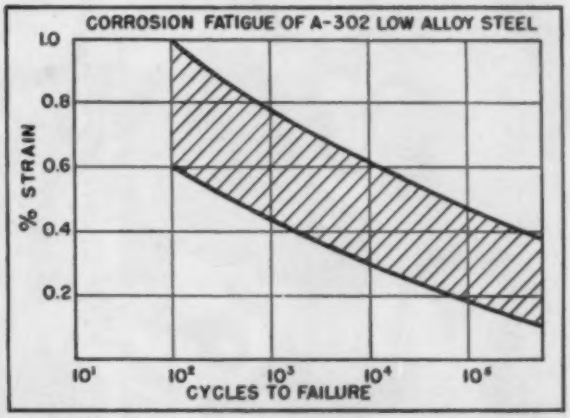
Evaluation of Low Alloy Steels for Nuclear Power Plants

One important phase of metallurgical research and development conducted at Bettis Atomic Power Division concerns the application of more economical non-core materials to the stringent requirements of nuclear reactor plant components.

To reduce the cost of nuclear power, Bettis Plant metallurgists are trying to find substitutes for the special stainless steels and expensive fabrication methods now employed. In connection with this program, they are investigating the behavior of the carbon and low alloy steels for use in the primary coolant of a nuclear reactor.

To eliminate the expensive stainless steel cladding in pressure vessels, Materials Engineering at Bettis Plant is investigating the suitability of a high strength manganese-molybdenum steel (ASTM A-302, Grade B) for reactor vessel construction. However, the reactor vessel, which contains the nuclear core, experiences many thermal transients causing very high cyclic strains in the vessel walls. In addition, carbon steels have relatively high corrosion rates in water at 600° F under a pressure of 2000 psi. To determine if the corrosion of the carbon steel reduces its fatigue strength, extensive experimental work is being carried out.

In one such study, Dr. Eric Rau, senior engineer, has been testing the corrosion fatigue resistance of ASTM A-302 to high strains in corroding water environment. Fatigue specimens, placed in specifically designed equipment, are subjected to very high plastic strains, up to 1% strain per cycle. Five specimens of varying thicknesses are tested simultaneously. Thus five points on a strain versus cycle-to-failure diagram are obtained in each run. Also the time per cycle can be adjusted to observe the frequency effect on high strain fatigue. Dr. Rau plans to conduct these tests at a frequency as low as one cycle per minute.



The cross-hatching in the graph indicates the strain range to be investigated. Fatigue specimens will be strain cycled in primary coolant water at 600° F. In each experiment five points on the strain vs cycles-to-failure curve will be obtained.

From the results shown by the strain versus cycle-to-failure diagrams, reactor designers can better determine the applicability of these materials to new designs.

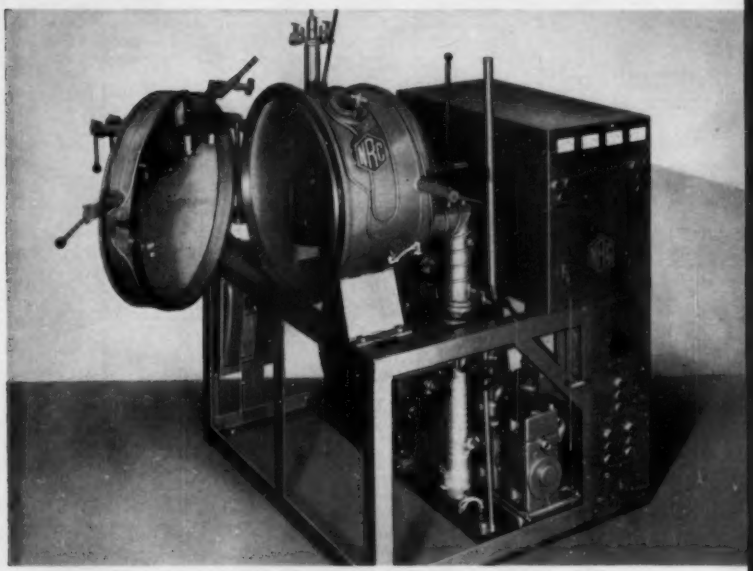
This is only one example of the challenging work awaiting you here. We welcome confidential inquiries from metallurgists interested in the excellent careers offered by the new and growing nuclear power industry. Please address your résumé to: Mr. M. J. Downey, Bettis Atomic Power Division, Westinghouse Electric Corporation, P. O. Box 1468, Dept. A-188, Pittsburgh 30, Pennsylvania.

BETTIS ATOMIC POWER DIVISION

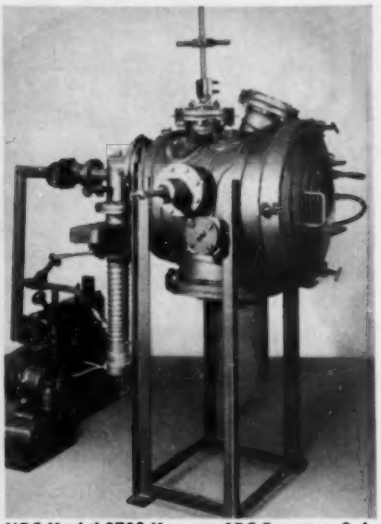
Westinghouse

Get Started Easily In Vacuum Metallurgy

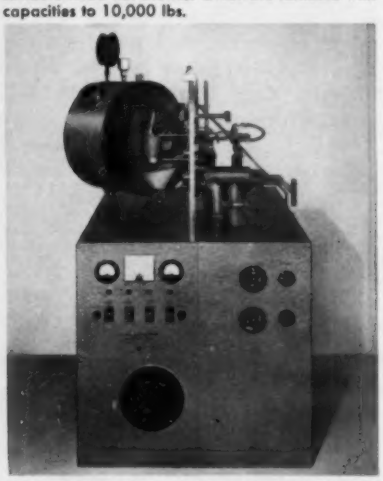
NRC experience and standard ARC, INDUCTION and RESISTANCE furnaces can remove the mystery from vacuum metallurgy



NRC Model 2551 Vacuum INDUCTION Furnace. Packaged facility for melting, purifying, alloying, casting and heat treating. Capacity 12 lbs. Other standard and special induction furnaces with capacities up to 5000 lbs.



NRC Model 2703 Vacuum ARC Furnace. Safe and versatile unit for consumable or nonconsumable electrode melting into cold mold or skull (consumable head not shown). Other arc furnaces with capacities to 10,000 lbs.



NRC Model 2904-B Vacuum RESISTANCE Furnace. Over 100 now in use for melting, purifying, alloying, casting, sintering, brazing, annealing, and heat treating. Capacity 2-8 lbs. Temperature above 2000°C. Pressures to 10^{-5} mm Hg. Other standard resistance bell, muffle, and pit furnaces with hot zones to 54" dia. by 12'.

If you're considering vacuum metallurgy as part of your product improvement or quality control program, you don't have to start from scratch. You can get a head-start by drawing on the experience NRC has gained from building and operating more high vacuum furnaces than any other organization in the world. You can easily find out

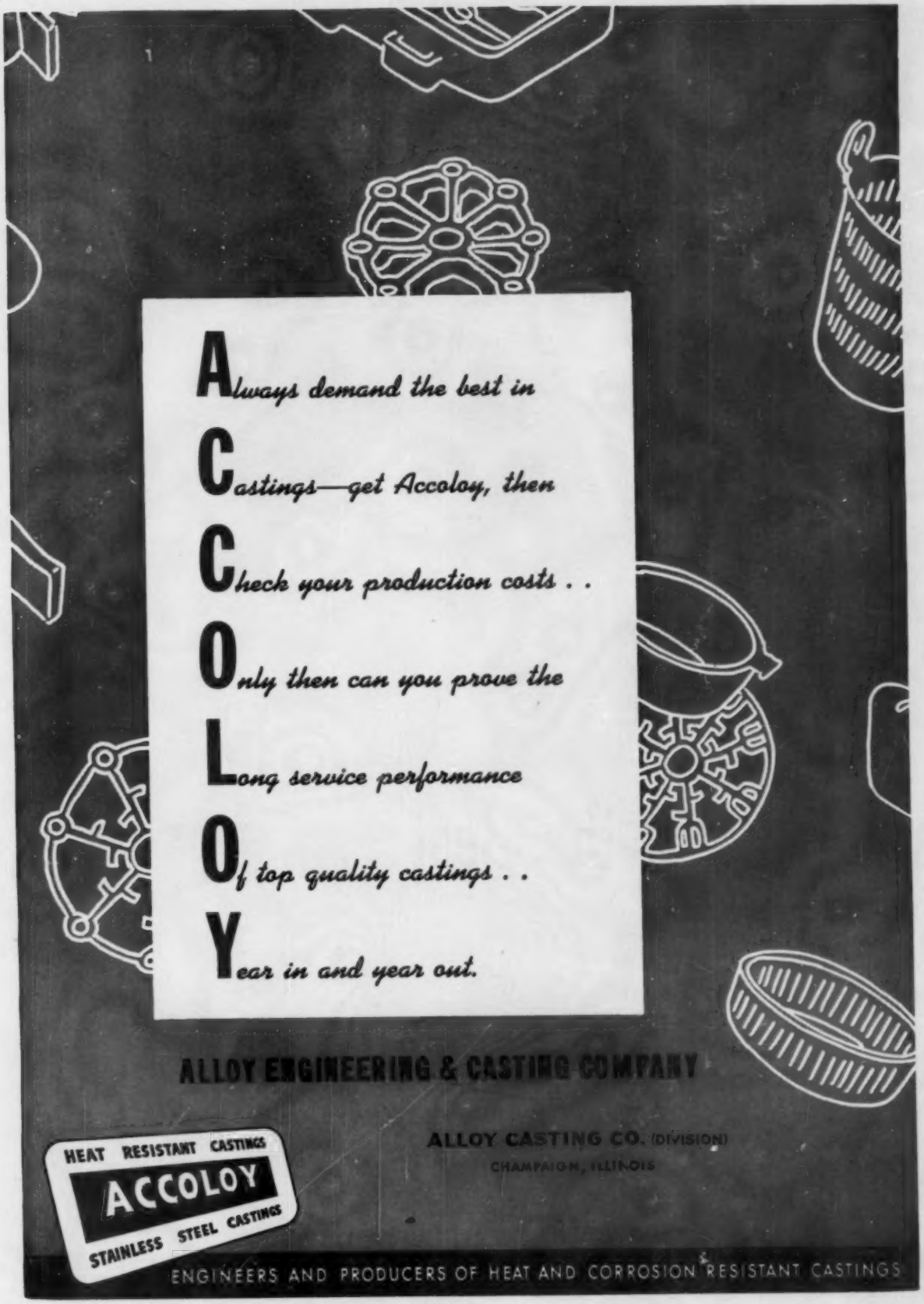
If vacuum metallurgy can help you as it has others.
Whether you really need to run your own development program.
What type of furnace would be most suitable for your program.
How to avoid the expensive pitfalls which have so often trapped beginners.

Then, if you decide to run your own development program, you'll find you can get started easily, economically and quickly with a standard NRC furnace, such as those shown here. You won't need a vacuum expert to run it either. NRC furnaces are designed for simplicity, and our engineers will teach you up-to-date operating techniques. This is the way for you to get useful results sooner, with a minimum investment in equipment, time, and operating costs.

Get started easily by writing for more information today.

NRC
NRC
EQUIPMENT
CORPORATION

DEPT. 1J, CHARLEMONT ST., NEWTON 61, MASS.
A Subsidiary of National Research Corporation


Always demand the best in
Castings—get Accoloy, then
Check your production costs . .
Only then can you prove the
Long service performance
Of top quality castings . .
Year in and year out.
ALLOY ENGINEERING & CASTING COMPANY
ALLOY CASTING CO. (DIVISION)
CHAMPAIGN, ILLINOIS
HEAT RESISTANT CASTINGS
ACCOLOY
STAINLESS STEEL CASTINGS
ENGINEERS AND PRODUCERS OF HEAT AND CORROSION RESISTANT CASTINGS



A Bundle of the Best...

and there's a size and type of Wallace Barnes high carbon strip steel to meet *your* specific use. Supplied in annealed state, hard-rolled, and hardened and tempered. Great forming properties, too. Get the facts.

WALLACE BARNES STEEL DIVISION

ASSOCIATED SPRING CORPORATION

BRISTOL, CONNECTICUT

ALSO MAKERS OF SPRINGS • WIRE FORMS • SMALL STAMPINGS

DIVISIONS OF ASSOCIATED SPRING CORPORATION — COAST TO COAST

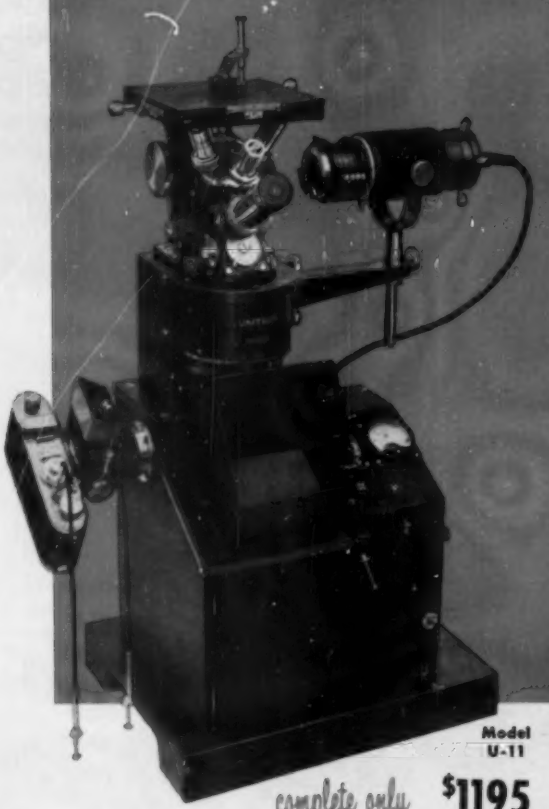
8719

© 1957 A.S.C.

These typical 17 together took 71

Here are 17 discriminating buyers whose 71 orders and reorders prove complete satisfaction with these UNITRON instruments.

AMERICAN BRASS	MINNEAPOLIS HONEYWELL
CARNEGIE INSTITUTE	UNION CARBIDE & CARBON
E. I. DU PONT	MISSOURI SCHOOL OF MINES
GENERAL ELECTRIC	REYNOLDS METALS
GENERAL MOTORS	U. S. GOVERNMENT
GOODYEAR ATOMIC	UNIV. OF CINCINNATI
I. B. M.	UNIV. OF WASHINGTON
M. I. T. WESTINGHOUSE ELECTRIC	R. C. A.



Model U-11

complete only $1195

BINOCULAR MODEL only $1379

UNITRON METALLOGRAPH and Universal Camera Microscope, Model U-11: A completely self-contained instrument of modern design for visual observation, photography, projection and measurement of both opaque and transparent specimens, using bright-field, dark-field or polarized illumination. While compact in size, it duplicates the performance of large, cumbersome instruments. Even laboratories on a limited budget can enjoy the accuracy, speed and efficiency possible only with a complete installation of this type.

- Standard optics include 5 parfocal objective lenses with revolving nosepiece, 4 photographic eyepieces on a revolving turret, 3 visual eyepieces, all coated. Magnification range: 25-2000X.
- High-intensity illuminator with variable transformer built into the microscope base.
- Built-in 3¼" x 4¼" camera. The image is automatically in focus in the camera and transition from observation to photography is instantaneous.
- Calibrated square mechanical stage with calibrated rotatable stage plate.
- Calibrated polarizing apparatus, transmitted-light accessories for transparent specimens, filters, micrometer eyepieces, film holders, cabinets, dustcovers, etc. all included.
- Additional accessories, available at extra cost include: Polaroid Land Camera attachment for "60-second" photography; 35mm camera attachment; low power (5-40X) objectives; vacuum heating stage for temperatures to 1100°C.





Model MEC

complete only $399

BINOCULAR MODEL only $599

UNITRON INVERTED Metallurgical Microscope, Model MEC: Many of the features of the UNITRON Metallograph U-11, which are connected with visual observation of opaque specimens, are included in this compact unit. Think of the time which can be saved in your laboratory by providing each metallurgist with one of these handy, inexpensive units for use at his desk. Model MEC is also ideal for use together with a polisher or microhardness tester.

- Standard optics include 4 parfocal objective lenses: 5X, 10X, 40X, 100X oil immersion on revolving nosepiece; 3 eyepieces: PSX, Micrometer 10X, K×15X, all coated. Magnification range 25-1500X.
- Vertical illuminator with iris diaphragm. Transformer housed in microscope base. A microswitch on the base provides an extra high intensity for photography.
- Binocular model has provision for attaching 35mm camera to microscope base. A 35mm camera attachment is available to attach to the eyepiece tube of the monocular model.
- Calibrated square mechanical stage with calibrated rotatable stage plate.
- Calibrated polarizing apparatus, 5 filters, dustcover, cabinet, etc. all included.
- Additional accessories available at extra cost include: 35mm camera attachment; K20X eyepiece for 2000X; transmitted-light accessories for transparent specimens; vacuum heating stage.

THIS COMPLETE CATALOG ON UNITRON MICROSCOPES IS YOURS FOR THE ASKING

FREE 10 DAY TRIAL on any UNITRON MICROSCOPES . . .

Let the instrument prove its value to you — in your own laboratory — before you decide to purchase.

UNITRON INSTRUMENT DIVISION OF UNITED SCIENTIFIC CO.

204-206 MILK STREET • BOSTON 9, MASS.

Please send me your complete catalog on UNITRON Microscopes.

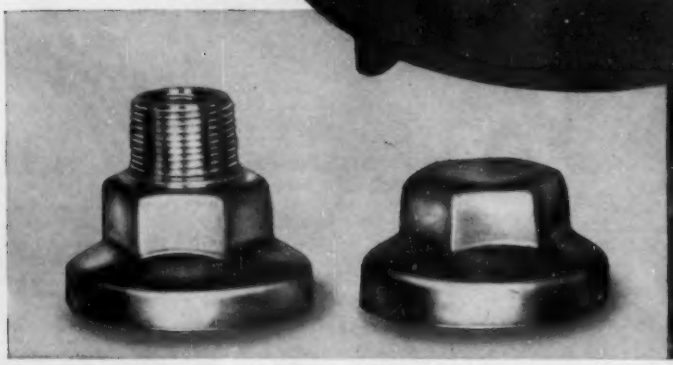
Name and Title _____

Company _____

Address _____

City _____ State _____







Pickling eliminated . . . To form these radiator steam vent shells requires nine drawing operations and four anneals. Prior to the use of a steam Homo furnace, pickling was necessary after each anneal, then a heavy pickle and buffing before chrome plating. Since switching to steam annealing this midwestern manufacturer has been able to eliminate all pickling . . . uses only a quick buff and bright dip before plating. Not only did the furnace pay for itself in a few months through handling and labor savings, but die life has considerably improved due to the clean surfaces of the brass.

Zero rejects . . . Beryllium-copper parts, such as switch and amplifier components for electrical equipment which must be plated after age hardening, heat treat in steam atmosphere with minimum oxidation . . . come from the furnace so much cleaner than in air that subsequent pickling operations can be substantially reduced and the difficulty of rejects eliminated.

The switch components above, for instance, formerly required pickling in hot sulphuric acid, a hydrochloric acid dip and a bright dip before plating . . . and plating rejects averaged 25%. Annealing in a steam atmosphere eliminated the two acid dips by preventing scale formation. Costs came down even more because the cleaner parts reduced the reject rate to zero.



Catalog TD2-620(1) tells all about it too;
we'll be glad to send you a copy.

Cut your Pickling and Cleaning Costs . . . with Steam Treating!

If pickling and cleaning operations are part of your production costs . . . on either ferrous or non-ferrous metals . . . there's a good chance steam atmosphere heat treating will prove an unsuspected source of surprisingly substantial savings for you.

Within the past few years, many plants have successfully overcome surface cleaning problems on structural steel alloy parts . . . have substantially reduced or eliminated pickling between draws of brass fittings and parts . . . have reduced rejects due to oxidation on parts of beryllium-copper and aluminum. In short, steam atmosphere heat treating has proved an easy, safe, inexpensive shortcut to uniform, scale-free metal surfaces.

On the opposite page are just four examples to illustrate our point. If you want others . . . or details on any of these . . . or want us to help investigate possible savings in your plant, just phone your nearest L&N office or write us at 4927 Stenton Ave., Phila. 44, Pa.





Buffing cost cut 40% . . . Many aluminum parts used as electrical and machinery components fabricated from the hardenable alloys such as Alcoa 61S or 75S require a final chemical or mechanical cleaning after solution treating. On such parts solution treating in a steam atmosphere results in a more uniform, more metallic and more reflective surface finish, compared to the duller matte finish obtained in air. A typical example are these aluminum alloy clutch arms. Solution treating them in a steam atmosphere saved up to 40% of the cost of subsequent buffing operations.

Threads kept clean, uniform . . . In the manufacture of hardened bolts and studs, cold-headed bolts, etc. for automotive and aircraft use, surface cleanliness of threaded sections becomes extremely important to speed-up assembly operations. In other cases where torque-indicating wrenches are used, the presence of surface scale can easily cause a false reading resulting in improper tightening and subsequent premature failure of the bolt. When such parts are steam tempered after hardening they come out clean and free from scale, with a uniform blue-black finish. When pickling is necessary, prior to plating or other surface finishing, the uniformity of the surface finish results in substantially reduced pickling time. For example, pickling time prior to plating the cold-headed bolts above was reduced 66% and rejects were eliminated, after steam treating became standard procedure.

LEEDS Instruments **NORTHRUP** Automatic Controls • Furnaces



This part finished better, cost less when degreased with NIALK® TRICHLORethylene

What do you do when a part that's supposed to be bright and glossy comes out of the vapor degreaser dull—tarnished—unacceptable for finishing?

This was the problem facing The Plume & Atwood Mfg. Co., Thomaston, Conn.

Plume & Atwood manufactures pen caps, pen barrels and lipstick cases by the million to their exceptionally rigid quality specifications. But the high luster buffed into these parts was being lost in the degreaser. Tarnished spots suddenly started to show up, making a good coating job impossible.

(This is a fairly common problem in vapor degreasing. It's caused by the solvent you use turning acid. Solvent can go sour rapidly—unless it's protected by a neutral stabilizer that doesn't lose strength.)

Plume & Atwood tried several different conventional degreasing solvents, without success. Results were "inconsistent"; solvent life was much too short. To keep the bath from going sour, P and A had to dump and clean out the degreaser *every three weeks.*

Solved...with NIALK

Then P and A switched to NIALK TRICHLORethylene. Result: immediate improvement. The first charge of NIALK solvent functioned without trouble for *nine weeks.*

There's no telling how much longer this charge would have continued in service, for at this point P and A installed newer degreasing equipment. Since then, NIALK TRICHLORethylene *has remained in service more than six months without once going sour.*

As a result, P and A feels that the tarnish problem is solved for good. Parts now come out of the degreaser untarnished and immediately ready for further processing.

"We're getting considerably better solvent mileage," says John Bradford, P and A's assistant to the plant manager, "and much improved gloss and luster at lower cost—thanks to NIALK!"

Only NIALK has psp

This example shows why you get *more effective, lower-cost* degreasing when you use NIALK TRICHLORethylene with **psp**—*permanent staying power.*

You *never* have to replenish the neutral stabilizer in NIALK. Even after many distillations, it's still there—working to prevent acid formation and other causes of breakdown. You go much longer, and degrease many more parts, between cleanouts. Cleanouts are easier, too, because NIALK actively retards the formation of degradation products in your degreaser.

For better degreasing, do this

See for yourself how you can keep *your* degreasers operating efficiently with NIALK—long after other solvents have lost their punch. Write us today on your business letterhead for the complete facts, including a resume of comparative metallurgical tests on five leading brands.

HOOKER ELECTROCHEMICAL COMPANY
409 Union Street, Niagara Falls, N. Y.

HOOKER CHEMICALS PLASTICS

DUREZ® PLASTICS DIVISION • NORTH TONAWANDA, N. Y.
NIALK® CHEMICALS • NIAGARA FALLS, N. Y.
OLDBURY® CHEMICALS • NIAGARA FALLS, N. Y.

Sales Offices: Chicago, Ill.; Detroit, Mich.; Los Angeles, Calif.; New York, N. Y.; Niagara Falls, N. Y.; Philadelphia, Pa.; Tacoma, Wash.; N. Tonawanda, N. Y.; Worcester, Mass. *In Canada:* Hooker Chemicals Limited, N. Vancouver, B. C.

Even in GREEK ... it's all very clear

A - Absolutely
B - BEST BY TEST
Γ - Globar's NEW
Δ - DELTA elements

... more durable ... more dependable

NOW IT CAN BE TOLD

After two years and hundreds of customer field tests ... Globar's new DELTA Silicon Carbide Heating Elements are unbeatable from *every* consideration. Shortly after Globar engineers perfected the Delta Elements, they were released to the field in restricted quantities and sizes to assure *performance* before public announcement.

Customer reaction speaks for itself:

- Delta Elements outperform *any* competitive element.
- Delta Element operation is more economical ... uniform resistance means fewer tap changes ... longer life ... lower operating costs.
- Delta Element terminals do not overheat, provide trouble-free connections. Elements can be installed in hot furnaces ... minimizes downtime.
- Delta Element resistance characteristic ... low at room temperature ... allows easy periodic operation.
- Delta Elements are available in a wide range of sizes to meet every application requirement ... regular sizes normally available from stock or within two weeks of order. Superior in *performance* and superior in *availability.*

TECHNICAL SERVICE AND LITERATURE. *Globar's exclusive service ... a field staff of Electrical Engineers backed by 30 years experience is ready to assist you — without obligation. Technical Bulletin "H" is available upon request. Write Dept. MP 87-715.*

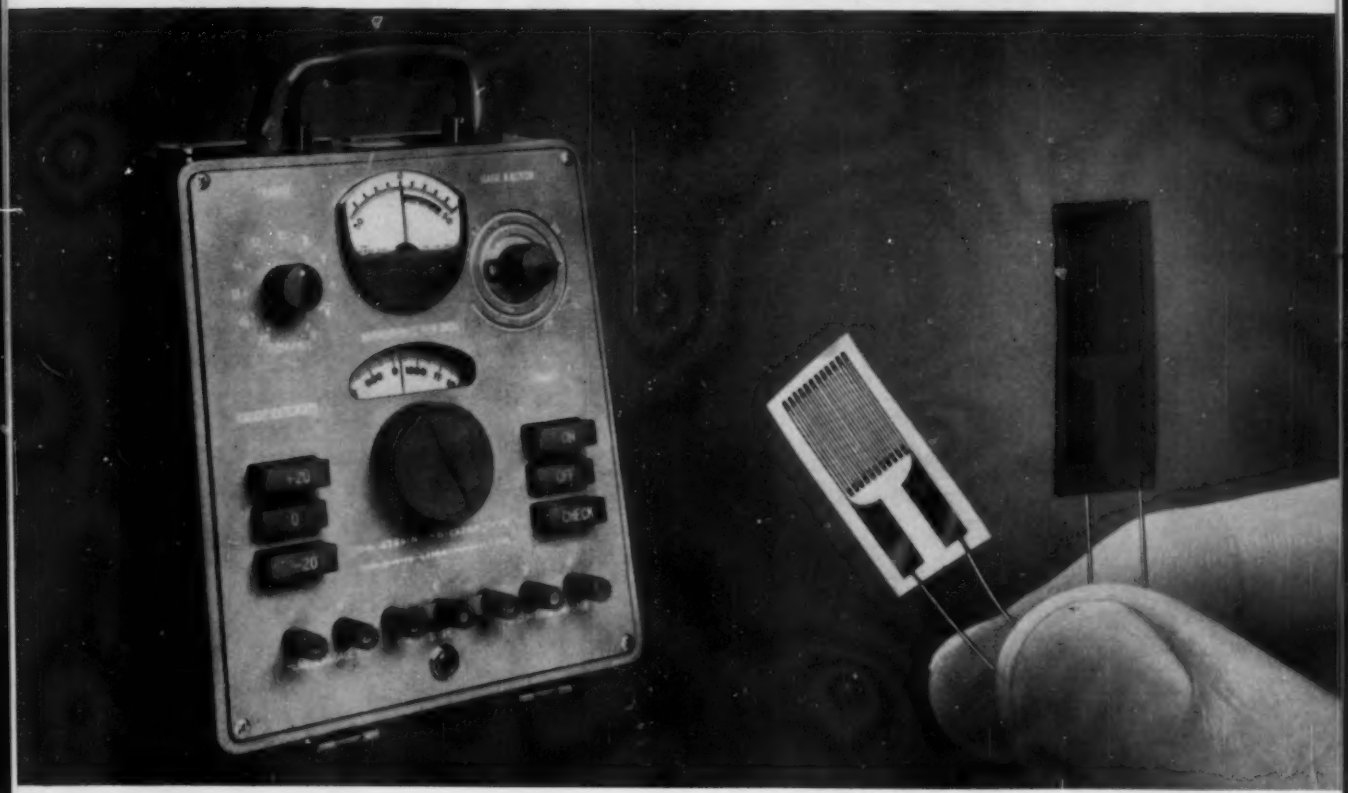
87-715 R

Globar®

DURABLE DEPENDABLE DELTA ELECTRIC HEATING ELEMENTS

GLOBAR Division of THE CARBORUNDUM COMPANY, Niagara Falls, New York

Newest strain-measuring equipment from Baldwin



Foil gages shown above are enlarged to twice their actual size.

NEW SR-4® strain indicator and NEW SR-4 bonded foil strain gages

Type N SR-4 Strain Indicator

This new, improved strain indicator features printed circuits and transistors, weighs one-third less than the previous model and has a smaller case. No warmup is required. In intermittent service its batteries last up to five times as long and cost two-thirds less. The legs of the case are positioned to permit tilting for improved readability. For direct readings with full external bridge, no calibration correction is required. Used as a preamplifier with standard cathode ray oscilloscope, it gives visual indication of dynamic strain with better response and in a broader range than the previous model. Frequencies up to 300 cps at amplitudes up to 3500 microinches per in. can be observed without appreciable distortion.

SR-4 Bonded Foil Strain Gages

Two new types of foil gage in ½ in. gage length, 120 ohms resistance, now make many types of stress analysis possible with new accuracy and ease. A Bakelite-bonded gage, Type FAB-2, and a quick-drying paper-and-cement-bonded gage, Type FAP-2, have marked advantages over comparable standard bonded wire strain gages. Hysteresis is now so low as to be negligible for stress analysis. Fatigue life of the paper gage matches that of comparable wire gages—that of the Bakelite gage is longer. Lateral strain sensitivity of both is down by one-half, offering new accuracy in measuring biaxial strains. The quick-drying paper gage is quick and easy to install. The Bakelite gage offers such attractive features as dependable service at 300°F or higher. It is thinner and more flexible than comparable bonded wire gages—requires no preforming for curved surfaces and is thus easier to apply. Its glass fiber filler makes it less sensitive to moisture effects.

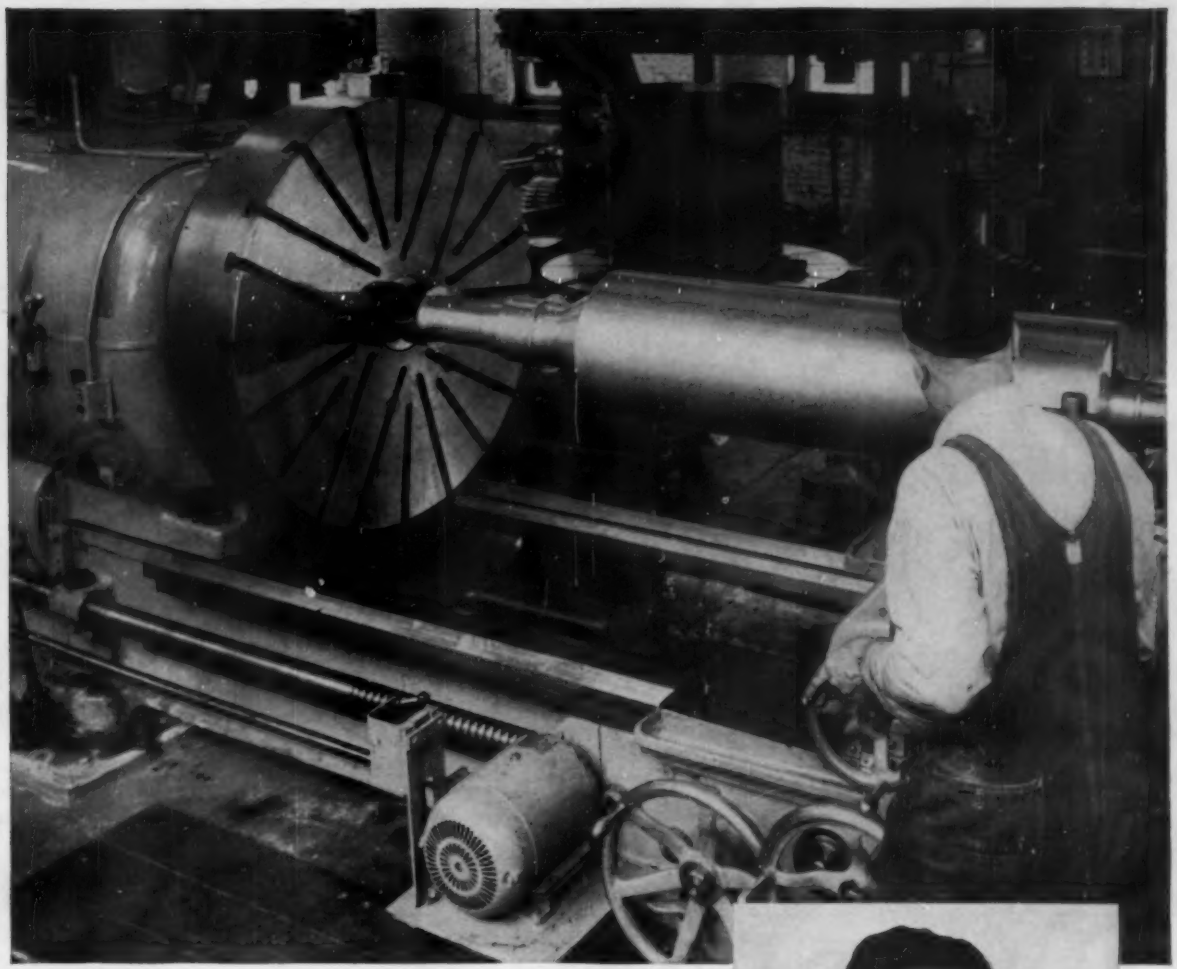
Both new foil gages have tinned lead wires, well anchored and easy to connect. Both gages are now stock items for prompt delivery. For more information on this or other Baldwin stress analysis equipment, write to Electronics & Instrumentation Division of B-L-H, Waltham, Mass. Or we will have a representative call on you at your request.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines



"Standard Steel castings and forgings play an important role in the 'New Look' at Vulcan Iron Works"

We at Standard Steel Works feel justly proud of the fact that our castings and forgings play "an important role" in both the quality and service which our several hundred customers are rendering to *their* customers. Vulcan Iron Works is typical of our customers—it consistently meets the quality and delivery requirements of its customers, and knows it can rely on us to help maintain its leadership as rotary kiln manufacturers.

Why don't you present your next forging or casting requirements to us. You too will find that when we at Standard Steel Works say that we give equal emphasis to quality *and* service to our customers, we mean what we say. Write Dept. 3-J.



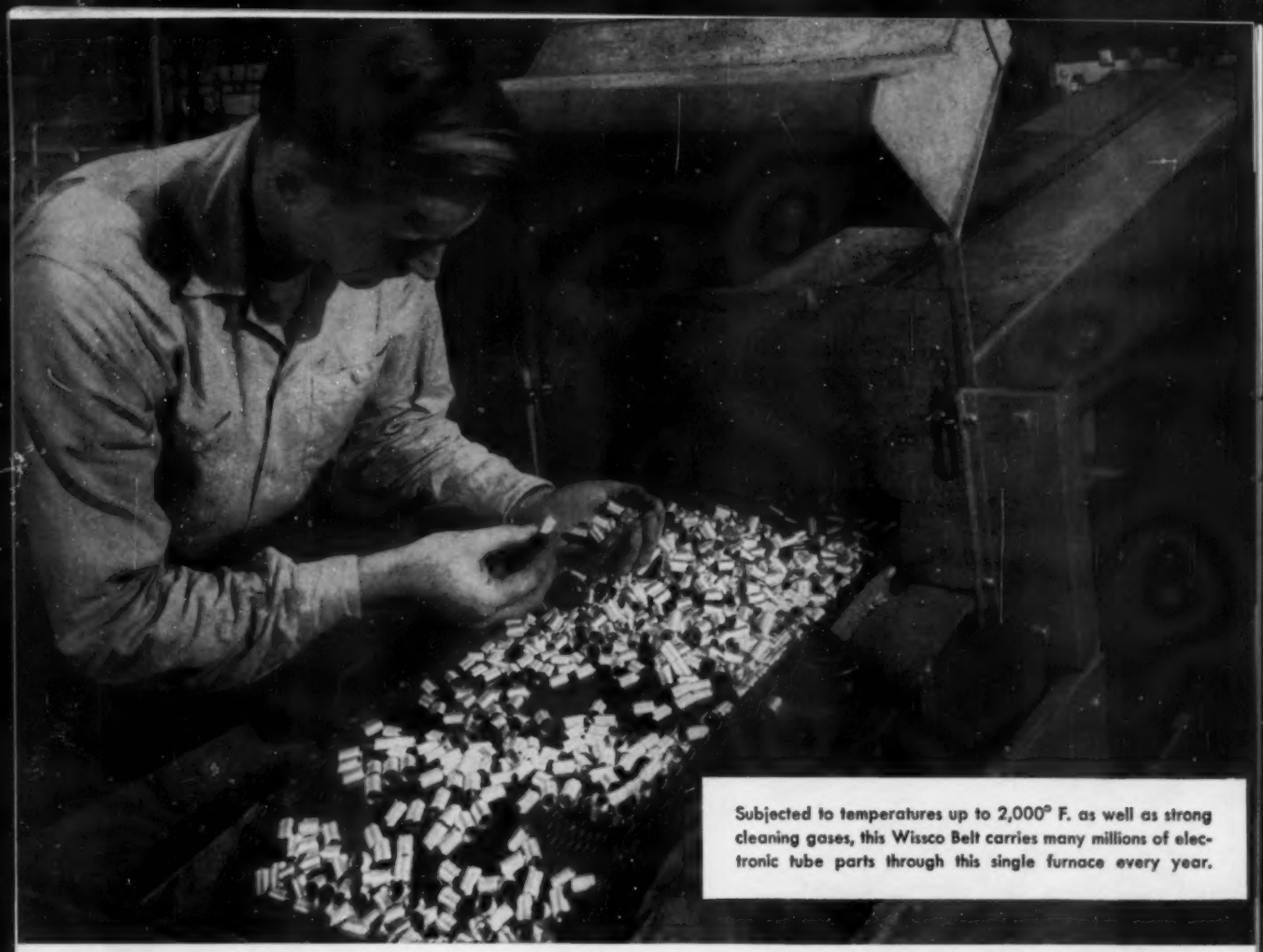
"When the new management took over at Vulcan, it immediately recognized the importance of better customer relations through faster deliveries and lower selling costs. Standard Steel's prompt service and quality products are helping Vulcan realize these objectives," says Mr. William J. Davis, plant superintendent, Vulcan Iron Works, Wilkes-Barre, Pa.

Standard Steel Works Division

BALDWIN · LIMA · HAMILTON

BURNHAM, PENNSYLVANIA

Rings • Shafts • Car wheels • Gear blanks • Flanges • Special shapes



Subjected to temperatures up to 2,000° F. as well as strong cleaning gases, this Wissco Belt carries many millions of electronic tube parts through this single furnace every year.

FAMOUS NAMES
ride on WISSCO BELTS

Tung-Sol Electric, Inc. • Washington, N. J.

The story of Wissco Belts is best told by their users. For instance, Tung-Sol Electric reports:

"Our Wissco Belts performed without interruption for 4 years of continuous, 24-hour-a-day, 7-day-a-week operations . . . "

In spite of high temperatures and strong gases, that's the record of two Wissco Belts operated by one of America's well-known electronic parts manufacturers.

What's more, these two belts enabled Tung-Sol to increase production by 100% while reducing furnace feeder crews by 50%. "In a strictly cost accounting sense, the belts paid for themselves within a matter of weeks," according to the company's production control chief, Mr. Allen Mayberry. Yet the reliability of the belts is even more important, he points out, because millions of component parts used by the company each year must pass over one of these belts. "The Wissco Belts and the two electric furnaces in which they operate are so essential to our operation that our volume production quotas are based upon their output."

If you have any kind of processing or conveying operation, Wissco Belts can help you, too. Get the complete story today from the nearest sales office listed below.

THE COLORADO FUEL AND IRON CORPORATION
Denver and Oakland

WICKWIRE SPENCER STEEL DIVISION
Atlanta • Boston • Buffalo • Chicago • Detroit • New Orleans • New York • Philadelphia

CF&I OFFICES IN CANADA: Toronto • Montreal

WISSCO BELTS
PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

CF&I

4371



. . . before Northwest developed these SPECIAL ALUMINUM CHEMICALS."

If you work with aluminum you'll be interested in Northwest's outstanding line of chemicals for use with modern alloys. Northwest's continuing research and development program has earned them the reputation of "First with the best" in this rapidly developing field. It will pay you to investigate:

Got a Problem?
Let our Cleaning Specialists help you!

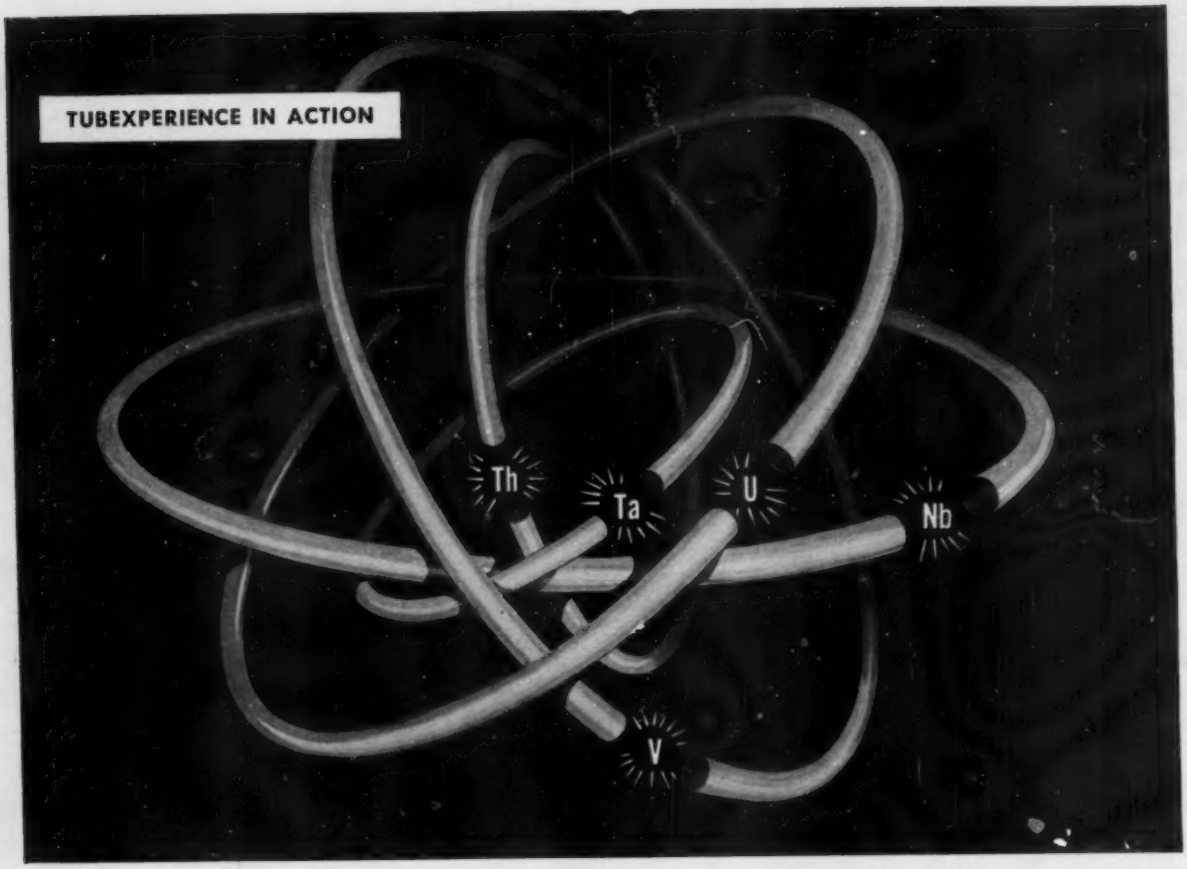


- **ALKALUME CLEANERS**—A full line of cleaners and etching compounds especially formulated for use on aluminum alloys prior to plating, anodizing, painting or welding.
- **ALKALUME PRE-PLATE**—An especially effective zincate bath for preparing aluminum for plating.
- **ACID SOLVENT EMULSION CLEANER No. 1**—An effective cleaner for fabricated aluminum parts before finishing.
- **DRAWING AND STAMPING COMPOUNDS FOR ALUMINUM**

NORTHWEST CHEMICAL PRODUCTS are manufactured on the West Coast by—

ALERT SUPPLY COMPANY
2041 South Davie • Los Angeles 22, California

NORTHWEST CHEMICAL CO.
9310 ROSELAWN DETROIT 4, MICH.



NEED TUBING FOR ATOMIC POWER?

Superior is your most reliable, experienced source

PROOF:

- *Superior has supplied millions of feet of tubing for atomic applications to many of the key manufacturers in the atomic field.*
- *Superior has already successfully manufactured tubing from uranium, vanadium, niobium, tantalum and thorium.*
- *Superior has 9 years' experience in drawing tubing from titanium and titanium alloys.*
- *Superior was the first mill to produce tubing from Zirconium, Zircaloy-2, and Zircaloy-3.*

. . . And Superior has produced all this tubing to exceptionally precise specifications and tolerances!

Put Superior's experience and facilities to work for you! Superior has drawn most of the reactive metals, as well as stainless steels, nickel alloys, ingot iron, and Inconel, for important nuclear applications.

The end uses for Superior tubing in atomic energy include control rod tubing, fuel element tubing, tubing for moderator and shielding cans, process lines for handling radioactive liquids, and tubing for handling facilities.

NOTE: In some cases, tubing can be produced only with AEC release, because of priorities on materials.

If you are in or serving the atomic industry and need small tubing, this store of experience can be of great assistance to you. For information, write Superior Tube Company, 2008 Germantown Ave., Norristown, Pa.

SEND FOR LATEST DATA ON ZIRCONIUM—*Write for your free copy of Special Analysis Memo 112—on zirconium, covering properties, fabrication and other data.*

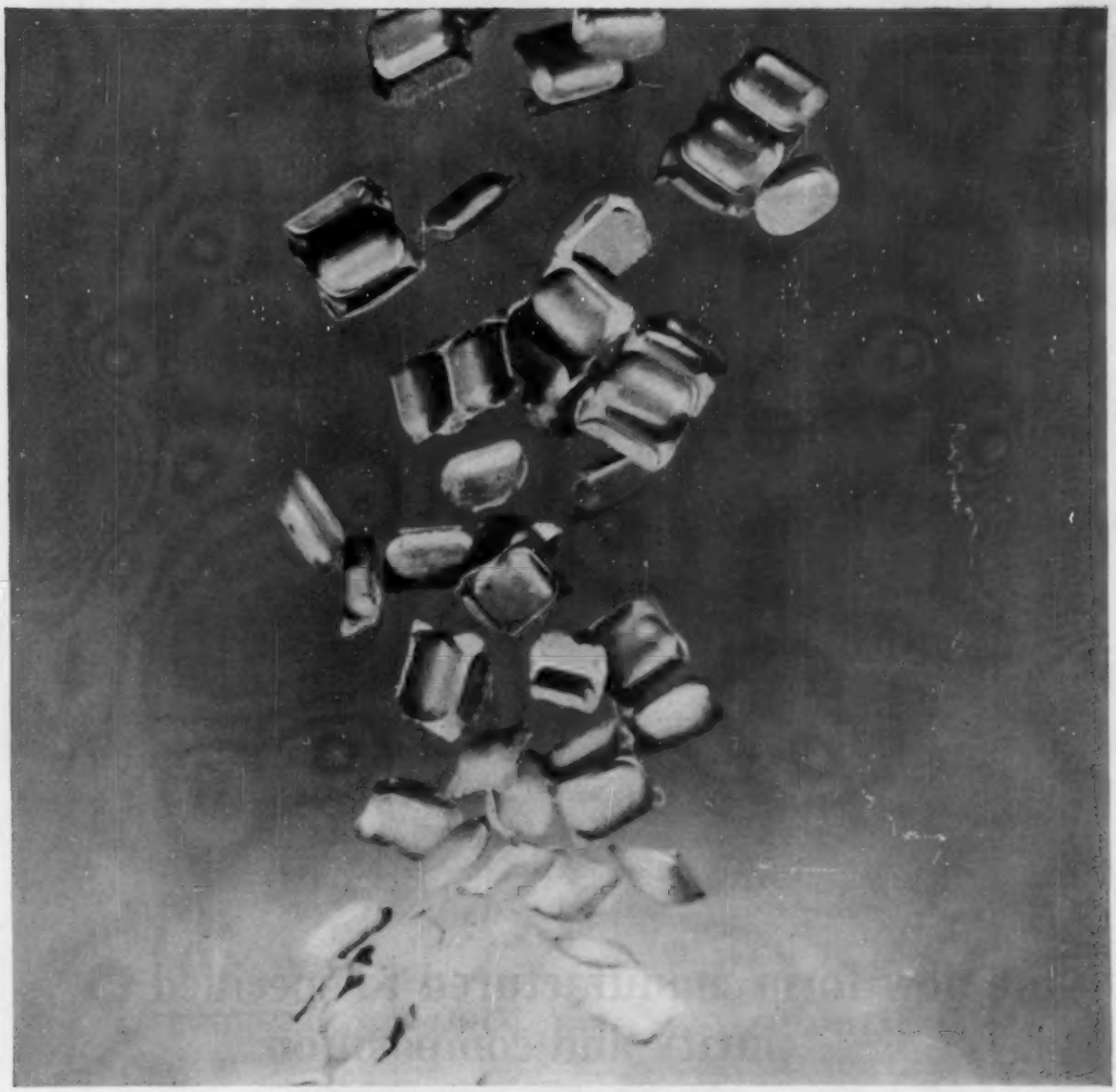
Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Co., 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331



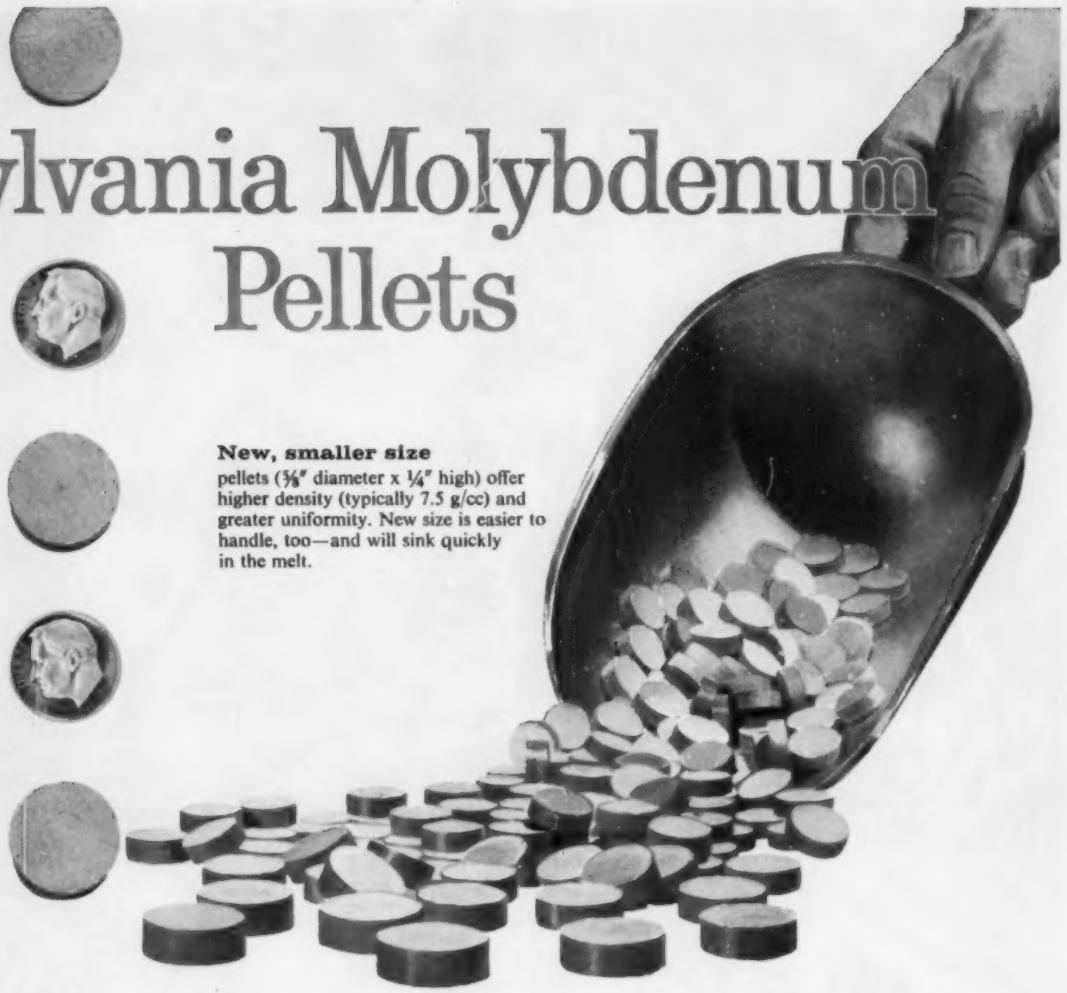
TITANIUM BRIQUETTES...

IN PRODUCING SUPER ALLOYS and stainless steel, you'll get higher titanium residual with reduced additions of TAM titanium briquettes...plus efficient deoxidation and stabilization. The convenient uniform size and shape of the briquettes make them easy to handle. They offer higher efficiency—dissolve readily and produce a cleaner metal with low aluminum and silicon and non-metallic inclusions. Titanium powder is firmly compressed into TAM briquettes...*which do not crumble during handling.* Shipped in metal drums. For prices and delivery data, contact our New York City office.

TAM PRODUCTS
Registered U. S. Pat. Off.

TITANIUM ALLOY MFG. DIVISION
NATIONAL LEAD COMPANY
Executive and Sales Offices:
111 Broadway, New York City
General Offices, Works and Research Laboratories:
Niagara Falls, New York

Sylvania Molybdenum Pellets



New, smaller size
pellets (⅜″ diameter x ¼″ high) offer higher density (typically 7.5 g/cc) and greater uniformity. New size is easier to handle, too—and will sink quickly in the melt.

—the new form manufactured to specified purity and composition

Sylvania Molybdenum Pellets are designed and manufactured specifically for use in vacuum melting. They provide a readily available source of the best purity molybdenum (typical 99.85%) available on the market. Detrimental impurities are at an extremely low level. This consistent high purity simplifies the calculation of additions to each melt as the usual variations of purity and gas content are eliminated.

By maintaining a high density, the gas content of the pellets is kept well below that acceptable for vacuum melting. In addition, the compact uniform size of the pellets facilitates weighing and charging to the melt.

When you use Sylvania Molybdenum Pellets, you benefit in other ways, too. Their continuous availability means you can plan your production schedules on a long-range basis. Further, their pricing stability permits you to price your own product without having to worry about fluctuating raw materials costs.

Call your Sylvania representative or write for details.

SYLVANIA ELECTRIC PRODUCTS INC.
Tungsten and Chemical Division, Towanda, Pa.

TUNGSTEN • MOLYBDENUM • CHEMICALS • PHOSPHORS • SEMICONDUCTORS

SYLVANIA

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY

NATIONAL ENGINEERING SERVICE

on

Heat and Corrosion Resistant Castings and Fabrications

General Alloys Company products are backed by a national engineering service offering unexcelled mechanical and metallurgical Heat and Corrosion Resistant Alloys for all Defense and Industrial applications.

"There is no substitute for Experience"

GENERAL ALLOYS BRANCH OFFICES AND REPRESENTATIVES

BALTIMORE, Maryland
Emil Gathmann, Jr.
513 Park Avenue

CHICAGO, Illinois
General Alloys Company
Edward T. Connolly
224 S. Michigan Ave.

DETROIT 2, Michigan
General Alloys Company
Don B. Hutchins
3-147 General Motors Bldg.

ROCKFORD, ILLINOIS
Benjamin F. Oilman
226 River Drive

MUNCIE, Indiana
The George O. Desautels Co
P.O. Box 779
408 Wysor Bldg.

BUFFALO 2, New York
General Alloys Company
P.O. Box 2366
Buffalo 23, N.Y.

CLEVELAND 15, Ohio
E. E. Whiteside
2254 Euclid Ave.

FORT WAYNE 8, Indiana
The George O. Desautels Co.
P.O. Box 1176
2506 Broadway

LOUISVILLE 7, Kentucky
The George O. Desautels Co.
4083 Hyeliffe Avenue

NEW ENGLAND
David L. Ellis
Hayward Mill Road
West Concord, Mass.

BIRMINGHAM, Alabama
Harry G. Mouat
544 American Life Bldg.

DENVER, Colorado
Tracy C. Jarrett
95 S. Ammons St.

HOUSTON 3, Texas
Wm. E. Brice Co.
305 Bastrop St.

INDIANAPOLIS 8, Indiana
The George O. Desautels Co.
2302 N. Meridian Street
P.O. Box 7011

NEW YORK 7, New York
General Alloys Co.
Alfred M. Sampter
80 Church Street

PHILADELPHIA, Pa.
General Alloys Co.
Bernard J. Conway
P.O. Box 2714

PITTSBURGH 15, Pa.
Vincent C. Leatherby
104 Fourth St.
Sharpsburg, Pa.

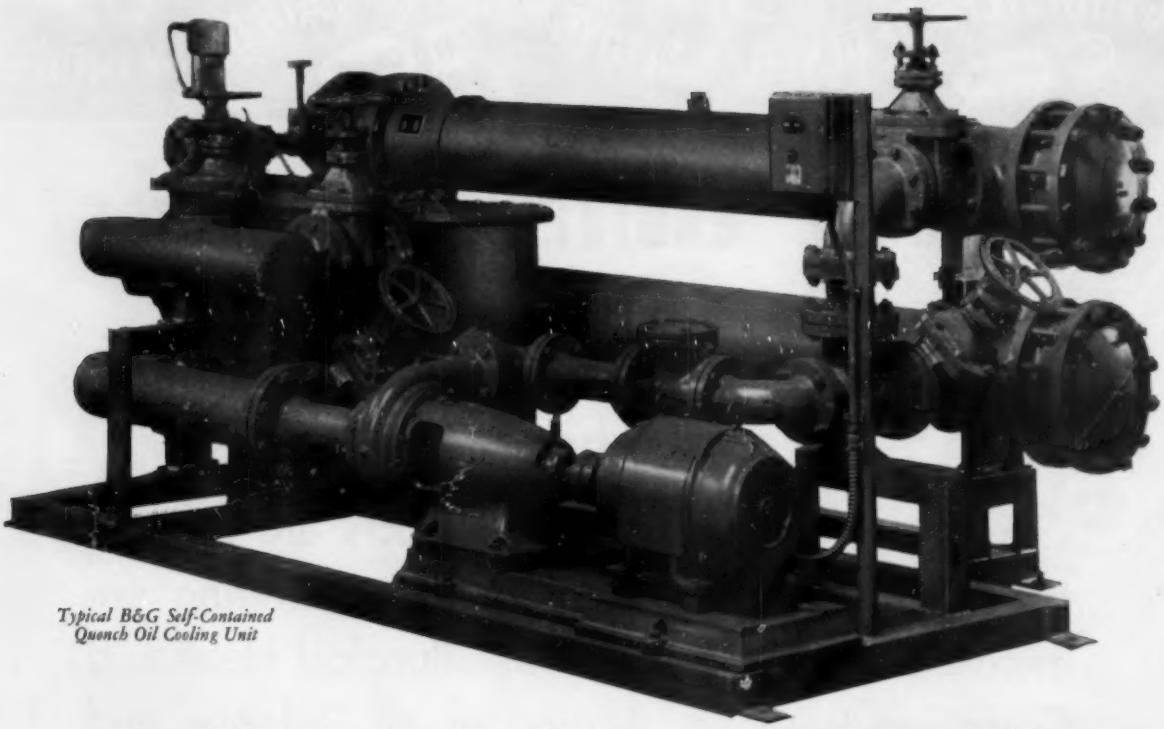
ST. LOUIS 15, Missouri
Associated Steel Mills, Inc.
P.O. Box 4235
Tower Grove Station

GENERAL ALLOYS COMPANY

405 WEST FIRST STREET **BOSTON, MASS.**

"OLDEST AND LARGEST EXCLUSIVE MFRS. OF HEAT & CORROSION RESISTANT CASTINGS"

GA ALLOYS THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION X-ite



Typical B&G Self-Contained Quench Oil Cooling Unit

Complete in every detail for

Controlled

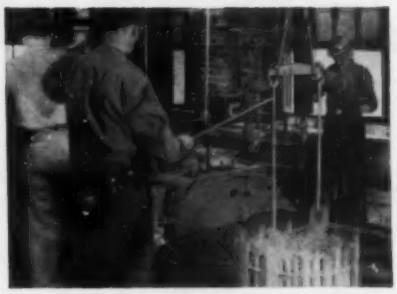
QUENCH OIL COOLING

Proper control of quench oil temperature is the certain way to maintain uniform quality in heat-treated metals and to avoid excessive sub-standard rejects. The only question is how to provide that control in the most practical, efficient manner.

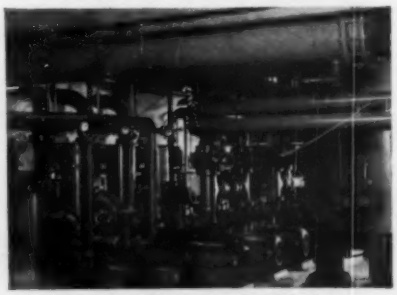
While the individual components of an oil cooling installation can be purchased and assembled on the job, the trend today is to install completely factory-assembled oil cooling systems.

To meet this demand, B&G offers completely self-contained oil cooling units—integrated in every respect—ready for immediate operation. These units are engineered to your specific requirements.

Whether your heat treating volume is large or small, the services of the B&G engineering department are available. Your request for information will receive prompt attention.



Every piece uniform in quality because uniformly quenched



Battery of B&G Quench Oil Coolers



B&G QUENCH TANKS

Properly designed to induce maximum turbulence in the quench oil. B&G Quench Tanks are available in standard models or can be built to meet any specific quenching requirement.

●

Send for this combined Catalog and simplified Selection Manual for B&G Self-Contained Quench Oil Coolers



B&G

Hydro-Flo*

OIL QUENCHING SYSTEMS

BELL & GOSSETT COMPANY

Dept. EY-16, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, W. Toronto

*Reg. U.S. Pat. Off.

MOLY NEWS

CLIMAX MOLYBDENUM COMPANY, 500 FIFTH AVENUE, NEW YORK 36, N. Y.

Super-Strength Structural Steels Boost Minimum Yield Strengths to 150,000 psi.

Seven steel companies in the U. S. are now producing a group of "Super-Strength Structural Steels" with considerably higher yield strengths than the well-known "High-Strength Low-Alloy" steels.

These Super-Strength steels offer minimum yield strengths ranging from 55,000 to 150,000 psi. And they have other useful properties, depending on composition, including strength at moderate temperatures, toughness at low temperatures, and good wear resistance. Almost all of these steels contain molybdenum as an essential element.

The search for steels with greater yield strengths has gone on for many years. Before about 1930, carbon steels with a yield point of roughly 30,000 psi were standard for almost all structural purposes. Then came the development of "High-Strength Low-Alloy" steels. They boosted minimum yields into the 50,000 psi range.

Now, the newer Super-Strength Structural Steels are being welcomed by designers, who see in them a way to solve one of their major problems — to minimize weight and size while retaining quality and reliability.

. . . For more information on these steels, including their trade names and compositions, circle number 1 on the coupon.

Moly's High Hot Strength Shows Promise for Jets and Rockets

Molybdenum-base alloys were described at the 1955 American Rocket Society annual meeting as having the greatest promise for true high-temperature operation.

Missile and powerplant designers are interested in moly mainly for its high temperature strength. Molybdenum-base alloys have been developed with higher useful strength at temperatures over 1600 F than any other presently known metallic material.

The jet propulsion field — including guided missiles and aircraft powered by rocket, ramjet, and turbojet engines — covers a tremendous variety of requirements and service conditions in respect to temperature, atmosphere, amount and type of stress, vibration, thermal shock, and prospective life. Molybdenum's properties make it a logical choice in many cases because it has:

1. High creep and rupture strength.
2. High tensile strength at high temperatures.
3. High modulus of elasticity.
4. A combination of high thermal conductivity, low specific heat, and low expansivity, which minimizes non-uniform temperature distribution and makes molybdenum insensitive to thermal shock.
5. High resistance to erosion by hot gases.
6. High melting point.

It seems safe to conclude that molybdenum-base alloys will become important structural materials in the jet propulsion field. And they will become essential for many parts operating at temperatures in excess of 1600 F.

. . . from "Molybdenum for High strength at High Temperatures," by R. Freeman and J. Briggs, JET PROPULSION, *February, 1957.*

For a copy of the complete article, circle number 2 on the coupon.

Moly Adds Strength and Corrosion Resistance to Titanium

Commercially pure titanium is fairly strong and highly corrosion-resistant. Alloying it, however, substantially increases these useful properties.

Molybdenum may prove to be one of the most useful of the alloying elements for titanium. Studies at Armour Research Foundation, for example, show that when molybdenum is used instead of vanadium, creep properties are greatly improved. At 1020 F, a stress of approximately 20,000 psi produces a creep rate of 10^{-4} in. per in. per hr in Ti-6 Al and Ti-6 Al-4 V, whereas 40,000 psi is required to produce the same creep rate in a Ti-7 Al-3 Mo alloy.

In summary, new alloy development is opening the way for titanium's extensive use in jet engines and air frames. Ti-Al-Mo alloys, for example, give better elevated temperature properties than the Ti-6 Al-4 V alloy now most widely used. And the alloy containing 7% Al and 3% Mo appears particularly promising.

Another Ti-Mo alloy contains 30 to 40% Mo. This alloy is claimed to resist boiling 40% sulphuric acid and boiling 20% hydrochloric acid as well as platinum, tantalum or gold. Such a retained beta alloy is weldable and could be fabricated into sheet. These corrosion-resistant characteristics would add to the value of all-beta Ti-Mo alloys.

. . . from "Molybdenum as an Alloy Addition for Titanium," by Harold Margolin, METAL PROGRESS, *February, 1957.*

For a copy of the complete article, circle number 3 on the coupon.

Moly Goes to Sea In A Sewer



Cast iron joint ring in pipe, before lowering into position. Joint rings were made by Alhambra Foundry Co., Ltd. and the concrete pipes poured by American Pipe and Construction Co.

Positioning 64 ton reinforced concrete sewer pipe sections puts quite a strain on the cast iron joint rings used to join them. Especially when the job is done under water at depths up to 210 feet.

Joint rings must be strong enough to withstand stresses developed when the pipe is drawn together, plus sufficient impact resistance to withstand handling and placement.

Those are good reasons why the County Sanitation District No. 2 of Los Angeles County specifies ASTM A 48, class 40 iron for the rings. In addition to the required 40,000 psi, tensile strength, and 2600 lb transverse strength minimum, (on a 1.2 in. test bar), the bar must be capable of deflecting at least 0.20 in. and the iron must contain at least 0.40% Cr, 0.60% Cu and 0.35% Mo.

Examination of pipe lengths after six years' service showed them in excellent condition. Equally good performance is expected from the most recent installations which extend some 8000 feet into the Pacific Ocean, and are believed to be among the largest in the country.

. . . For more information on the contribution of moly to toughness and shock resistance of cast iron, circle number 4 on the coupon.

Climax Molybdenum Company, Dept. 5,
500 Fifth Avenue, New York 36, N. Y.
I'd like more information on:
1 2 3 4

Name_____

Address_____

City_____

"THE CRUX OF THE HONEYCOMB SANDWICH WILL ALWAYS BE THE BOND"



*B-58 bomber designed and built by the Convair Division of General Dynamics Corporation, Fort Worth, Texas.



B-58 engine nacelle section. Stainless steel honeycomb structure whose light weight is evident. Its strength and aerodynamic qualities are attested to in flight in the world's fastest jet bomber.

This is a direct quote from a recent article on honeycomb structures in *Aeronautical Purchasing* magazine. It states exactly what authorities in the field of supersonic speeds already know, and clearly points up the aims and activities of Handy & Harman in this critical and challenging field.

One of the most significant applications of the honeycomb sandwich can be found in the United States Air Force new supersonic bomber, the B-58.* Elements of this "missile with a man in it" are made of high-strength stainless steel honeycomb sandwich, *bonded* with Handy & Harman special silver brazing alloys – a method which permits honeycomb assemblies of virtually any size.

The honeycomb principle needs no further testimonial. Indeed, the problems it solves and the obstacles it overcomes *now* can mean only that its future is immensely promising. Work with all kinds of materials; metals, ceramics, plastics, paper, etc., is now in progress to further increase its present great values.

Handy & Harman, with its knowledge and facilities in the field of joining metals, can be of great help to you in many of these honeycomb sandwich research areas. Many of the developments in silver alloy brazing, heating methods, production techniques and the formulation of special alloys for special needs, were originated by Handy & Harman. Your efforts in devising new methods in metal joining and in meeting present bonding needs can be helped, in large measure, when you call on Handy & Harman.

Your NO. 1 Source of Supply and Authority on Brazing Alloys

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

DISTRIBUTORS IN PRINCIPAL CITIES

OFFICES and PLANTS
ATLANTA, GA.
BRIDGEPORT, CONN.
PROVIDENCE, R. I.
CHICAGO, ILL.
CLEVELAND, OHIO
DETROIT, MICH.
LOS ANGELES, CALIF.
OAKLAND, CALIF.
TORONTO, Canada
MONTREAL, Canada

Norelco

PRODUCTS

INSTRUMENTATION FOR RESEARCH, MATERIALS CONTROL AND PRODUCTION

- X-ray Diffraction Equipment
- X-ray Diffractometers
- X-ray-Spectrographs
- X-ray Thickness Plating Gauges
- X-ray Absorption Apparatus
- X-ray Crystal Analysis Units
- X-ray Tubes and Rectifiers
- X-ray Cameras, Sample Spinners, Pole Figure Devices and Accessories
- Autrometer—24 Channel automatic Element Analyzer
- X-ray Custom Built Equipment for Special Applications
- Geiger, Proportional, Scintillation and Flow Type Detectors
- Electronic Circuits for High Speed Detectors with Pulse Height Analyzers
- Decade Scalers and Ratemeters
- Electronic Timers
- Line Voltage Regulators
- Radio Compass Controls
- Electronic Testing Equipment
- Electron Microscopes
- Electron Diffraction Equipment
- Emission Microscopes
- High Voltage Generators
- Contact Microradiographic Equipment
- Gas Liquefier
- High Pressure Equipment
- Industrial X-ray Equipment
- Industrial X-ray Fluoroscopes
- Industrial Image Intensifiers with Closed Circuit Television

Norelco

CMR

CONTACT MICRORADIOGRAPHY

FOR MICROGRAPHIC STUDY OF OPAQUE MATERIALS



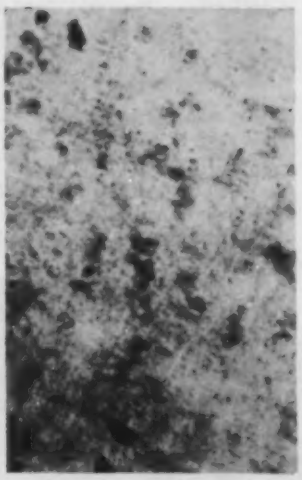
APPLICATIONS:
Metals, Alloys, Biology, Botany, Paints, Pigments, Textiles

As a complement to light microscopy, contact microradiography is supplying thru-focus (penetration) data on opaque, semi-opaque or transparent materials.

This growing technique eliminates the need of special preparations and conditioning of samples which normally introduce the question of artefacts and matrix distortion. Contact microradiography of materials in a natural state provides complete penetration studies of the superimposed structure of opaque materials in the order of 50 microns or greater.

This technique provides data which is otherwise unattainable. In addition, it provides an indispensable complement to microscopic techniques — not only where distortion must be verified, but also to reveal the superimposed details of opaque materials with ultra-sharp focus throughout the entire thickness of the sample. Because of the straight-line penetration characteristics of X-rays, critical studies of internal structures of semi-transparent and transparent structures may be routinely made. In practice, the specimen is placed in contact with a fine-grain film. Vacuum camera may also be employed. An ultra-thin window X-ray tube provides select long wave radiation penetration. (1-1) micrographs can be enlarged 400-500x photographically.

Entire unit, operated from standard A.C. outlet, can be used in a safelighted darkroom without the need for protective provisions.



90% Cu - 2% Be - 20 micron section 5 Kv - 3 Ma - exposure time 4 mins. Enlargement 135 X.

PHILIPS ELECTRONICS, INC.

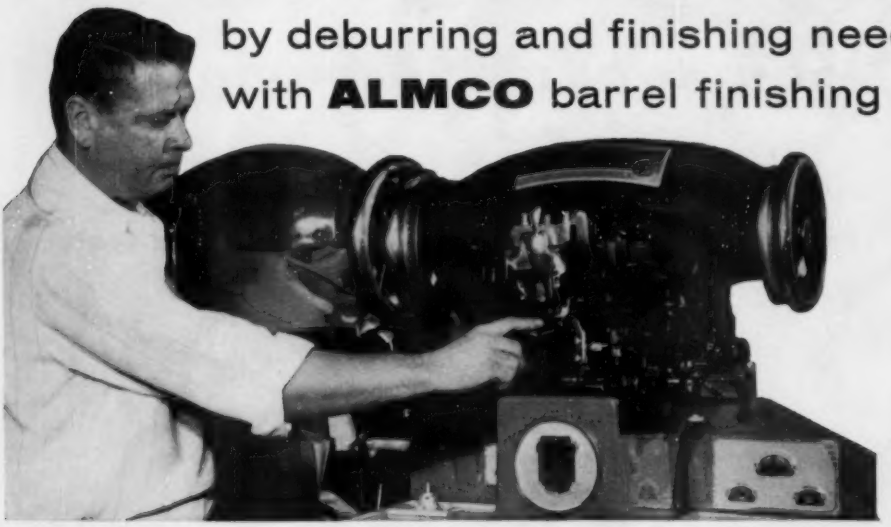
Instruments Division

750 SOUTH FULTON AVENUE, MOUNT VERNON, N. Y.

In Canada: Scientific and Industrial Division, Philips Industries Limited, 11 Brentcliffe Road, Leaside, Toronto 17, Ont.

FINISHING ENGINEER AT LANDIS MACHINE CO. REPORTS...

"We cut costs from 55^{00} to 55¢ per 100 by deburring and finishing needle plates with ALMCO barrel finishing equipment"



MR. JAMES W. DUNFORD, finishing engineer at Landis Machine Co., St. Louis, points to location of needle plate in new model of Landis shoe repair machine.



BEFORE AFTER

One of the most successful barrel finishing applications on record at Almco is this needle plate deburring and finishing at Landis Machine Company.

The needle plate forgings are drilled and broached and then carefully deburred. Formerly the tough burrs were removed by hand filing at a cost of $55.00 per 100.

Now, an Almco Model DB-200 barrel finishing machine performs the same operation at a cost of 55¢ per 100, a savings of 99%!

MANY LANDIS PARTS NOW BARREL FINISHED

With this $3,200 annual savings on needle plates alone in mind, Landis engineers have applied the Almco method to other parts until the company is now barrel finishing several hundred different parts to high quality standards. Rejects are practically non-existent.

VERSATILE EQUIPMENT

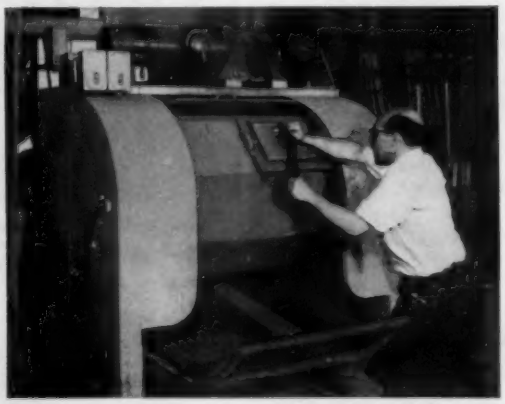
By keeping simple records on processing cycles, correct media and compound, and proper scheduling, Landis engineers can switch the Almco equipment from part to part, to meet plant production requirements exactly.

BROAD EXPERIENCE FOR YOU

Almco's experience in barrel finishing methods and techniques now covers a wide range of parts, sizes, shapes, metals, and operations. Almco maintains sample processing laboratories for the purpose of analyzing product parts and desired results. Let Almco technicians work out procedures to give you the quality you want at the lowest possible finishing cost.

REQUEST YOUR REPORT

Simply write on your company letterhead, requesting an Almco engineer to call on you. Or, send your sample parts and specifications on results direct to Almco. You will receive a detailed report at no obligation.



Finishing department operator at Landis Machine Co. gets ready for parts deburring run in Almco barrel finishing machine. Almco construction is heavy-duty throughout, to stand up under rugged requirements month after month.

SEND FOR THIS NEW BARREL FINISHING HANDBOOK

Complete description of the most advanced modern processes. 52 pages of facts, photos, data and cost comparison charts. Write for your personal copy today.



ALMCO

DIVISION OF QUEEN STOVE WORKS, INC.

95 Marshall Street • Albert Lea, Minnesota

Sales Engineering Offices in Chicago, Detroit, Los Angeles, Newark, New Haven, Philadelphia and London, England.

AT WHITE PINE COPPER MINE

USS "T-1" Steel consistently outperforms other materials*



*Feeder chute liners last 2 to 3 times longer

Hard and flinty copper ore plays hob with ordinary materials. That's why virtually all the feeder and transfer chutes in White Pine's crushing plant are now lined with USS "T-1" Steel. Quenched and tempered to 321 minimum Brinell, USS "T-1" Steel liners, ⅜" thick, have proved far longer-lasting than materials formerly used, and they give from 2 to 3 times longer service. These USS "T-1" Steel liners are easy to fabricate, are readily flame-cut to size—a great advantage over cast, anti-abrasive materials.

*Loader plates last 8 to 12 months longer

At White Pine Copper, USS "T-1" Steel supplied to 321 minimum Brinell, is used in the bottom and side plates of the conveyor of this loading machine. Also in the plates on its underside along which the returning conveyor chain slides. Prime requirements here are toughness and high resistance to impact abrasion. Every one of these underground loaders has been overhauled since the mine was opened and, in every case, USS "T-1" Steel has been used to increase durability. The result—8 to 12 months more service life. White Pine maintenance men report "T-1" Steel easier to flame-cut and weld than other steels used for this particular application.

WHITE PINE COPPER'S experience with USS "T-1" Steel is typical of the improvements in service that this remarkable steel makes possible. Wherever they have used it to replace former construction, equipment life has been materially increased. Repair and maintenance costs have been cut. Down time has been reduced. All this means savings in time and money—savings that are far greater than the difference in initial steel cost.

Here's why USS "T-1" Steel can help improve your equipment

When you want strength far beyond the ordinary, you can get it with USS "T-1" Steel—for, with a minimum yield strength of 90,000 psi and a minimum tensile strength of 105,000 psi, USS "T-1" Steel is nearly three times as strong as structural carbon steel. This is far higher yield strength than has ever before been available in weldable plate steel. What's more, its strength is not lowered by welding or gas cutting.

For equipment subject to impact abrasion, USS "T-1" Steel can be obtained quenched and tempered to a minimum hardness of 321 Brinell. Even this very hard grade can be welded and flame-cut *right in the field* without pre-heating. That means you don't have to shut down costly, high-capacity equipment for the many hours generally required for shop repairs.

If your equipment must withstand severe impact abuse, USS "T-1" Steel insures against damage in winter weather. Whether furnished to 321 minimum Brinell or to 90,000 psi minimum yield strength, it has exceptional toughness and resistance to brittle failure, even at temperatures far below zero.

Our new catalog—USS "T-1"—is complete with technical information and offers many practical suggestions for its use that can save *you* money. For your free copy, write to United States Steel Corporation, Room 2801, 525 William Penn Place, Pittsburgh 30, Pa.



United States Steel Corporation, Pittsburgh · Columbia-Geneva Steel Division, San Francisco
Tennessee Coal & Iron Division, Fairfield, Ala. · United States Steel Supply Division, Warehouse Distributors, Coast-to-Coast
United States Steel Export Company New York

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

"USS" and "T-1" are registered trademarks

UNITED STATES STEEL



NEW U. S. I. ZIRCONIUM PLATELETS ELIMINATE SAFETY PROBLEM

You're looking at a new form of zirconium —the non-pyrophoric, non-hygroscopic platelets produced by U.S.I.'s new plant at Ashtabula, Ohio. Zirconium platelets eliminate the handling hazards of the more familiar sponge metal because of their low ratio of surface to weight. Special shipping precautions are not required. Platelets also make possible a safer, cleaner melting operation.

Production of U.S.I. zirconium employs a new, semi-continuous sodium reduction process, yielding top-quality metal almost completely free of sodium, magnesium, chlorides, hydrogen and moisture. Prices are coming down too, and these will be reflected in lowered costs of fabricated parts. Zirconium equipment is expected to be available in the not too distant future for about twice the cost of stainless steel, depending upon the complexity of the part.

The new U.S.I. production facilities will make available an important new source of zirconium for both government and industrial use. By next year, a million pounds will be available for industry from U.S.I.'s new plant, over and above the million pounds per year committed to the A.E.C. Thus, a reliable source of high-quality zirconium will be available to the nuclear industry and to manufacturers of chemical processing equipment.

For further information write for the new booklet, "Zirconium and Hafnium". For detailed information and assistance on your particular problem, call Bill Greenleaf, Manager of Metals Development.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
Branches in principal cities



how Vacuum Metals FERROVAC solved critical surface problem for Bausch & Lomb . . .

The jewelers' rolls Bausch & Lomb use to roll gold-alloy wire for eyeglass frames must be *mirror-smooth*. Rolls of conventional air-melted alloys just didn't work out economically. A normal amount of nonmetallic inclusions in the metal meant they had to be ground and reground, polished and repolished, before the surface was satisfactory. And even then, many rolls had to be scrapped when finishing uncovered inclusion pits.

The solution to this problem proved to be Vacuum Metals FERROVAC® Airdi 150. A better finish was obtained without any regrinding—and the number of scrapped rolls fell to zero. Here's why: Vacuum-melting removes the gases which create nonmetallic inclusions in the molten metal before they get into the product. This means cleaner metal, smoother surfaces. What's more, vacuum-melting improves fatigue, creep and impact strengths . . . reduces brittleness.

Vacuum-melted metals are the answer to jobs where surface is critical—like gauge blocks, plug and ring gauges, rolls for aluminum foil—as well as many other specially demanding applications. They're available in most grades and sizes, including special ferrous and non-ferrous alloys. Write now for a free analysis sheet on which to describe your application. It will help us both decide how vacuum-melted metals can serve you best. *Vacuum Metals Corporation, Division of Crucible Steel Company of America, P. O. Box 977, Syracuse 1, New York.*

VMC®

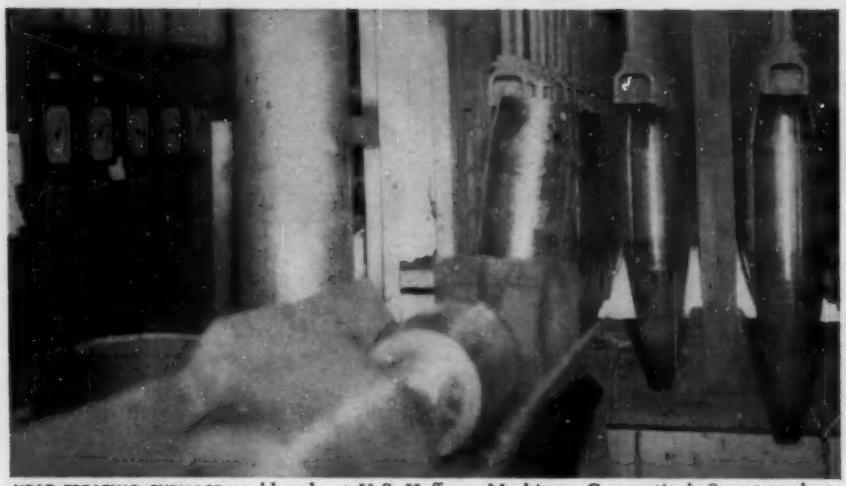
VACUUM METALS CORPORATION

Division of Crucible Steel Company of America

BRISTOL'S

Instrumentation News

• News of instrumentation and automatic control in industrial heating and metallurgy •



HEAT TREATING FURNACE—cold end—at U.S. Hoffman Machinery Corporation's Scranton plant. Heat treatment of projectiles, seen entering furnace at right, is automatically controlled by instruments at left.



INSTRUMENTS LIKE THESE control temperatures in rotary Hagan furnaces at U.S. Hoffman Machinery Corporation's plant. One of six installations.

World's largest hot-forge shell plant gets Bristol control

Continuous heat control is a must in the manufacture of high-explosive shells for the U.S. Army Ordnance Corps.

That's why you find Bristol Electronic Dynamaster* Pyrometer Controls at U.S. Hoffman Machinery Corporation's Scranton, Pa. plant—the world's largest hot-forge shell installation.

Rotary furnaces, built by George J. Hagan Co., heat the steel billets. Bristol control systems, using round-chart Bristol Dynamaster Pyrometers, continuously monitor and regulate the heat in three zones in each of these furnaces.

After forging and before machining, the shells are heat treated in a two furnace setup. Surface Combustion furnaces, also controlled by Bristol Pyrometers, heat the shells in the first stage before quenching, and second stage after quenching.

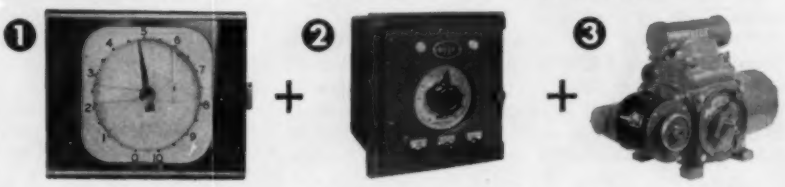
Bristol Series 536 Free-Vane* Electronic Pyrometers automatically cut off the oil in case of furnace overheating.

Bristol Pyrometers provide precise temperature control for any industrial heating installation. You'll find complete specifications and prices in Bulletin P1260. Write for your copy today. The Bristol Company, 106 Bristol Road, Waterbury 20, Connecticut. 6.44

*T. M. Reg. U. S. Pat. Off.

Here are the basic elements for finer temperature control. Hundreds of variations available.

1. Bristol Round-Chart Dynamaster Electronic Pyrometers.
2. Control relay.
3. Motor operator—for proportional positioning of final control units, such as valves, burners, rheostats.



There's a Bristol Controller for every furnace and oven.

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

XXIII

This is the twenty-third of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Annealing: Its Uses with Alloy Steels

Broadly speaking, the primary purpose of annealing is to soften steel and make it more workable. Annealing, as applied to alloy steels, may be defined as a process that heats above, and furnace-cools through, the critical range at a controlled, specified rate of speed; or that heats to a point within, and furnace-cools to a point below, the critical range. In either case, the choice depends upon the structure and maximum hardness desired.

The first method produces a lamellar pearlitic structure, while the second creates a spheroidized condition. These will be discussed separately in the following paragraphs:

(1) *Lamellar pearlitic structure.* It should be mentioned at once that this structure can be obtained both as described above and by a modified method known as isothermal annealing. In the isothermal process, the steel is heated above the critical temperature (austenitized), then transformed at a predetermined temperature, which depends upon the analysis. This operation requires two furnaces or salt baths —one for austenitizing, one for transformation.

Lamellar pearlitic structures are generally associated with machinability in carbon ranges from 0.20 to 0.60 pct, provided the hardness does not exceed the optimum maximum Brinell numeral. This is especially true where critical tooling is involved. It is a very versatile structure, as it gives best results in such operations as broaching, tapping, threading, deep drilling, boring, milling, and tooling as applied on single- and multiple-spindle bar automatic machines.

(2) *Spheroidized structure.* There are two general fields of use for this type of structure when alloy steels are employed. In the low and medium carbon ranges, spheroidization is necessary for cold-shaping operations, such as heading, extruding, drawing. In the higher carbon ranges (over 0.60 pct), it is mandatory where machining is involved, because it tends to lower the hardness of the steel.

As noted elsewhere in this discussion, both lamellar pearlitic and spheroidized structures can be created through annealing. If you care for more details about these and other uses of annealing, and the results to be expected, by all means consult with our technical staff. Bethlehem metallurgists will gladly help you work out any problems. And when you are ready for new supplies of alloy steels, Bethlehem can offer the full range of AISI standard grades, as well as special-analysis steels and all carbon grades.

If you would like reprints of this series of advertisements from No. I through No. XX, please write to us, addressing your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa. The first 20 subjects in the series are now available in a handy 36-page booklet, and we shall be glad to send you a free copy.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL





FORGING

Air Superiority for National Defense

A complete prototype service for the design and production of jet engine blades is ready to work for you at the Metals Processing Division of Curtiss-Wright. One of the most experienced blade producers in the industry – now turning out thousands of blades daily – the Metals Processing Division can contribute importantly at any stage of your operation . . . from blueprint through prototype . . . from processing of pilot quantities to full volume production.

The Division's precision controlled production means more accurate development now . . . smoother production later. Coordinated facilities for casting, forging, grade rolling, machining and extrusion round out the picture. Write today for qualified engineering consultation, without obligation.

78 GRIDER STREET

METALS PROCESSING DIVISION
CURTISS-WRIGHT
CORPORATION · BUFFALO, N. Y.

No matter which *FINISH* you like—you can buy it in

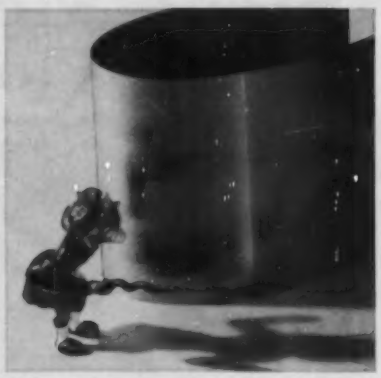
MicroRold® QUALITY STAINLESS STEEL



2D—A silvery white, but non-lustrous, surface produced by annealing and pickling cold reduced material. Steel sheets & strip in this condition are most ductile and the surface holds lubricant well for severe drawing operations.



2B—Steel in the 2D condition which is subsequently rolled on a "skin pass" or temper mill. The surface acquires a bright finish from the polished rolls. This surface is somewhat more dense and hard than 2D and is a better starting surface for later finishing and buffing operations.



No. 3—This surface is made by grinding with a No. 100 abrasive. This surface is smooth but not as reflective as 2B.



No. 4—A finer finish than No. 3 made by grinding with a No. 150 abrasive. Like No. 3, this surface is easily blended with hand grinders after forming, drawing or welding.



No. 7—Good reflectivity and brilliance made by polishing with a No. 400 abrasive. This semi-mirror finish must be protected during fabrication by adhesive paper or strippable plastics lest the finish be marred beyond repair.



BRIGHT—A highly reflective surface made by cold reducing with highly polished, glass-hard rolls. This finish is only available in Type 430 stainless.

These are our standard surface finishes that are available in types 201, 202, 301, 302, 304 and 430 except Bright which is type 430 exclusively.

These finishes are regularly supplied in sheet and coil form in widths up to 48 inches.

Since Nos. 3, 4, 7 and 430 Bright are smooth reflective surfaces, they are not recommended for severe drawing without special precautions as the mill finish may be marred. Applications such as dairy machinery, kitchen and restaurant equipment and architectural decorative work require only local forming, so these highly polished surfaces are not greatly disturbed. All mill polished sheets are carefully packed to avoid handling imperfections. Protective adhesive paper can be specified by the buyer when needed.

For specific information on recommended surface characteristics for a particular stainless steel sheet and strip application, address your request to our Product Development Dept.

WASHINGTON STEEL CORPORATION — MicroRold — STAINLESS — SHEET & STRIP

Washington Steel *Corporation*

Producers of Stainless Sheet and Strip Exclusively

9-T WOODLAND AVENUE, WASHINGTON, PA.

New---from H-VW-M

Sisal-Flex and Tufta-Flex Contour Buffs

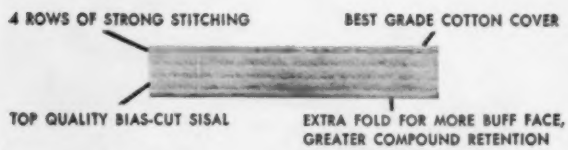


For fast, heavy-duty cutting on hard metal having contoured surfaces, choose flexible, strong, long-wearing new SISAL-FLEX Buffs! Overlapped SISAL-FLEX construction means cool running, no streaking, unusual pliancy. Check these features:

- **Best grade sisal is bias cut, then bound in top grade bias-cut cotton cloth . . . never frays, never scratches!**
- **Each buffing pad has *extra* fold . . . gives more buffing face, carries more compound on circumference and leading edges.**
- **Ventilated steel center, in 5", 7" and 9" dia. sizes. Note extra row of stitching around center.**
- ***Four rows of stitching*, for strength, longer wear.**
- **Also available with triple sewn buffing pads. Both types come in standard sizes from 12 to 18 inches in diameter.**

For fast, lighter cutting on contoured work where the final finish must be smoother, choose strong, unusually flexible, long-wearing new TUFTA-FLEX Buffs! Overlapped TUFTA-FLEX construction means no streaking, positive cutting, cool operation. Look for these special features:

- **Each buff pad made of strong 86/93 cotton—bias cut to prevent fraying, increase wear.**
- **Two rows of stitching—super flexible! Extra row of stitching around center.**
- **Double fold provides greater cutting face, extra compound-holding capacity.**
- **Ventilated steel center has rugged clamping teeth for safety.**
- **Available in standard sizes from 12 to 18 inches in diameter.**





Discover how new SISAL-FLEX and TUFTA-FLEX Buffs can mean *savings* in your buffing room! Write today for more information and prices. **Hanson-Van Winkle-Munning Company, Matawan, New Jersey. Offices in principal cities.**

3130

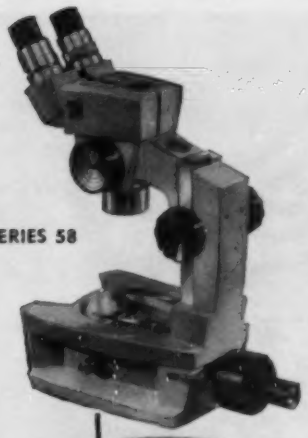
H-VW-M

Industry's Workshop for the Finest in Plating, Anodizing, and Polishing Processes • Equipment • Supplies

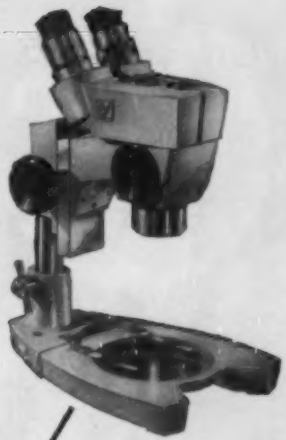
PLATEMANSHIP—Your H-VW-M combination—of the most modern testing and development laboratory—of over 80 years experience in every phase of plating and polishing—of a complete equipment, process and supply line for every need.



SERIES 56



SERIES 58



SERIES 59

available through

HARSHAW SCIENTIFIC

a completely new series of

Stereoscopic Microscopes

CYCLOPTIC

offers these outstanding features

- True three dimensional image
- Long working distance
- Reversible, inclined body
- Large field of view
- Durable EPOXY finish
- Top quality optics
- Broad selection of models
- LOW PRICE

Why not make this the week for you to discover that the new CYCLOPTIC Series offers you the exact model to meet your very need.



MAGNI-CHANGER

Desired magnifications simply "dialed-in" by rotation of calibrated cylinder



SERIES 53

GET THE WHOLE AO CYCLOPTIC STORY... REQUEST LITERATURE TODAY.

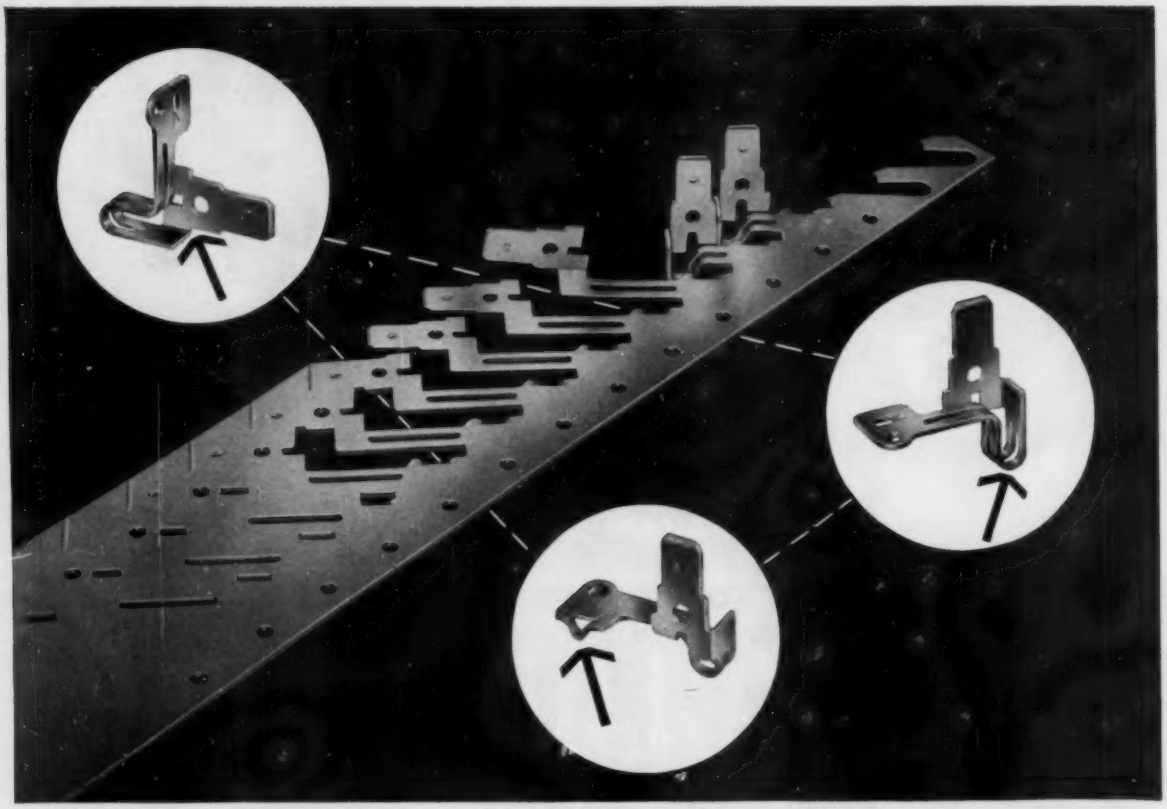
HARSHAW SCIENTIFIC

Division of the Harshaw Chemical Co. • Cleveland 6, Ohio

Sales Branches and Warehouses

Cleveland 6, Ohio 1945 East 97th St.	**Detroit 28, Mich.** 9240 Hubbell Ave.	**Los Angeles 22, Calif.** 3237 S. Garfield Ave.
Cincinnati 13, Ohio 6265 Wiehe Road	**Houston 11, Texas** 6622 Supply Row	**Philadelphia 48, Pa.** Jackson & Swanson Sts.

Sales Offices: Buffalo 2, N. Y. • Pittsburgh 22, Pa. • Oakland 11, Calif. Baton Rouge, La. • Hastings-On-Hudson, N. Y.



Cut costs on tough forming jobs with Elephant Brand® fine grain phosphor bronze

Automatic metal-forming machines operate best when they are fed materials of uniform, dependable quality. To shape critical details like those shown on these switch parts, many manufacturers rely on Seymour ELEPHANT BRAND phosphor bronze. Its fine grain permits making sharp bends, severe draws and other complex forming operations with a minimum of rejections or tooling adjustments.

Seymour ELEPHANT BRAND combines in one fine grain phosphor bronze alloy; high ductility, great strength, uniform temper, long fatigue life, and fine finish. These qualities prompt discerning users to say: — "Specify Seymour ELEPHANT BRAND . . . there's no finer phosphor bronze!"

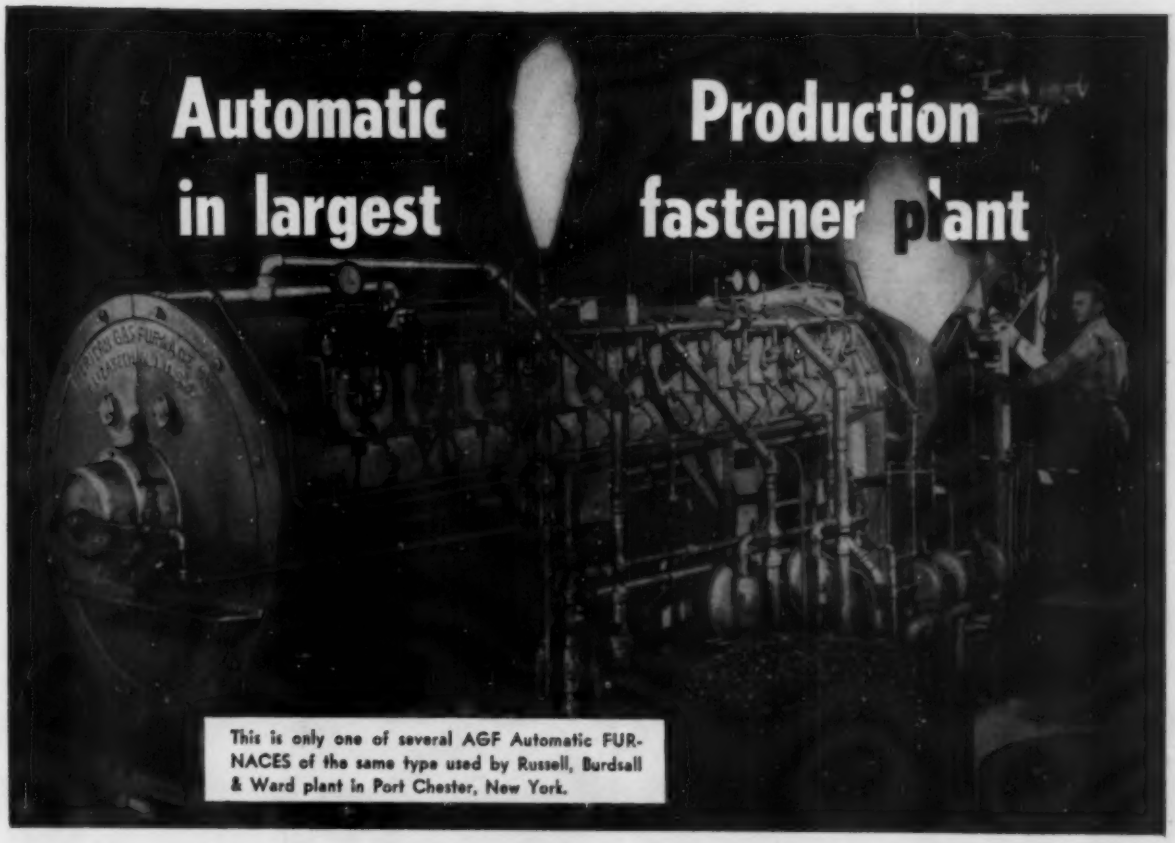
ALL ELEPHANT BRAND phosphor bronze is fine grain

The first phosphor bronze produced in the U.S. was ELEPHANT BRAND. Made by a carefully guarded process which insures the highest degree of purity and uniformity, it has a grain structure of very fine, uniform crystals free from segregation, coring or residual dendritic structure. Thus, ELEPHANT BRAND is a quality standard as well as a trade-mark for the original and finest phosphor bronze.

Your Seymour Representative is trained to help you solve metals problems. Why not call him today?

THE SEYMOUR MANUFACTURING COMPANY

10 FRANKLIN ST., SEYMOUR, CONNECTICUT



This is only one of several AGF Automatic FURNACES of the same type used by Russell, Burdsall & Ward plant in Port Chester, New York.

IT'S THE MODERN . . . . EASY WAY TO HEAT TREAT BOLTS, NUTS and other FASTENERS

Bolts, nuts, rivets, screws, pins, clips, screw machine parts of all kinds . . . and the wide area of stamped, forged and coined parts, products, accessories and components . . . all are most economically heat treated in AGF Rotary Retort Furnaces.

Small parts manufacturers have found that AGF Automatic Furnaces, substantially cut hardening costs whether their production need is under 150 pounds or over 800 pounds per hour. The clean and uniform results are due to rotary action of the retort which mixes the work, eliminating all possibility of overlap or "hot spots" . . . an exclusive AGF feature.

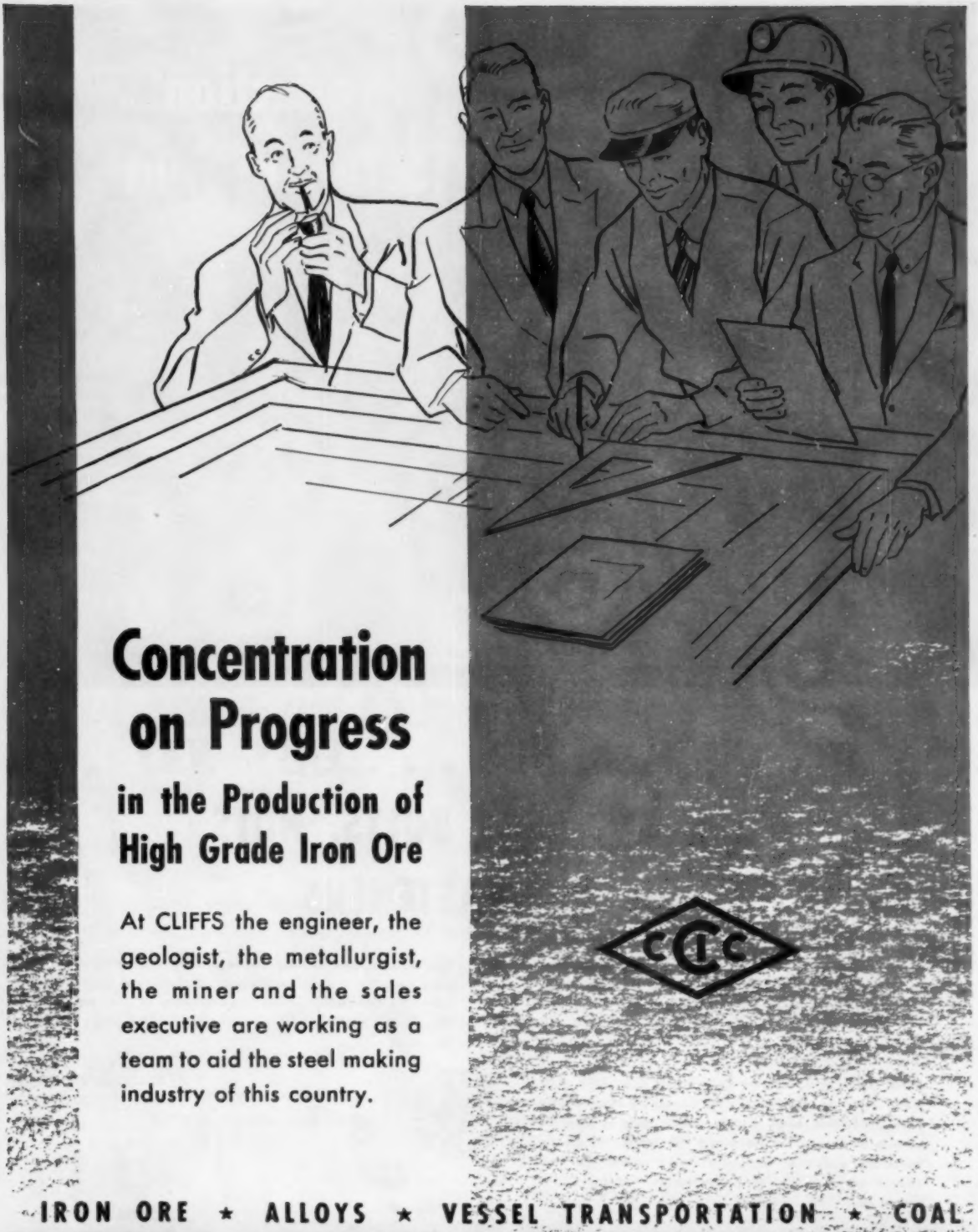
"PIONEER manufacturers of Industrial Gas Heat Treating Equipment since 1878"

The entire system can be engineered by AGF Metallurgists and Engineers at a minimum cost to you. Talk it over with the direct factory representative in your area. There's no obligation and no requirement is too large or too small.

MAIL COUPON

AMERICAN GAS FURNACE CO.
100 Lafayette St., Elizabeth 4, N. J.

My Name .....
Company .....
Street .....
City .....
Please send Bulletin No. 139 .....
Have Factory Rep. Call .....
Our Requirement is .....
.....



Concentration on Progress

in the Production of High Grade Iron Ore

At CLIFFS the engineer, the geologist, the metallurgist, the miner and the sales executive are working as a team to aid the steel making industry of this country.

IRON ORE ★ ALLOYS ★ VESSEL TRANSPORTATION ★ COAL

The Cleveland-Cliffs Iron Company

UNION COMMERCE BUILDING • CLEVELAND 14, OHIO



P&H now offers an outstanding improved E6010 Electrode

...to give you fast burn-off in all positions, for all purposes!

Here's the latest development in welding electrodes —P&H AP-100—a new improved mild steel all-purpose, all-position E6010 electrode with iron powder.

Arc characteristics are greatly improved. When whipping the electrode there is no tendency for the arc to snuff out. Vertical welds are easier, and free from holes. The weld bead is exceptionally smooth and evenly rippled. Weld quality is excellent, both for x-ray and mechanical properties.

Arc-force stays constant as the electrode burns, reducing stub loss. This, plus higher amperages, greatly increases deposition.

For more information about this remarkable new electrode, write to Dept. 321E, Harnischfeger Corp., Milwaukee 46, Wisconsin.

HARNISCHFEGER

P&H WELDERS • ELECTRODES • POSITIONERS

MILWAUKEE 46, WISCONSIN

3

3

three
reasons
why
it will pay you
to use

Federated

NICKEL ALLOY INGOT

1. **CONVENIENCE** of handling ingot instead of scrap is obvious. But in addition, while ingot costs a little more, you SAVE—on costs of handling, on space for handling and storing, on melting losses.

2. **UNIFORM ANALYSIS** — The analysis of nickel alloy ingot is always more uniform than that of a heterogeneous mixture of scrap. With Federated ingot, you don't take chances on possible contamination of heats.

3. **AVAILABILITY** — Federated Nickel alloy ingot is available for immediate use. Fast, dependable Federated service gets nickel to you when you need it.

This new Nickel alloy ingot is backed by the same thorough research and product development, and embodies the same high quality that has marked the whole line of products Federated has supplied to the steel industry for over 40 years . . . babbitts for bearings, Terne metal for plate, zinc alloys for galvanizing, ferro-selenium for stainless steel, and lead pellets for free-machining steel.

Why not get in touch with us today and learn more about why it will pay you to do business with Federated.

Federated Metals

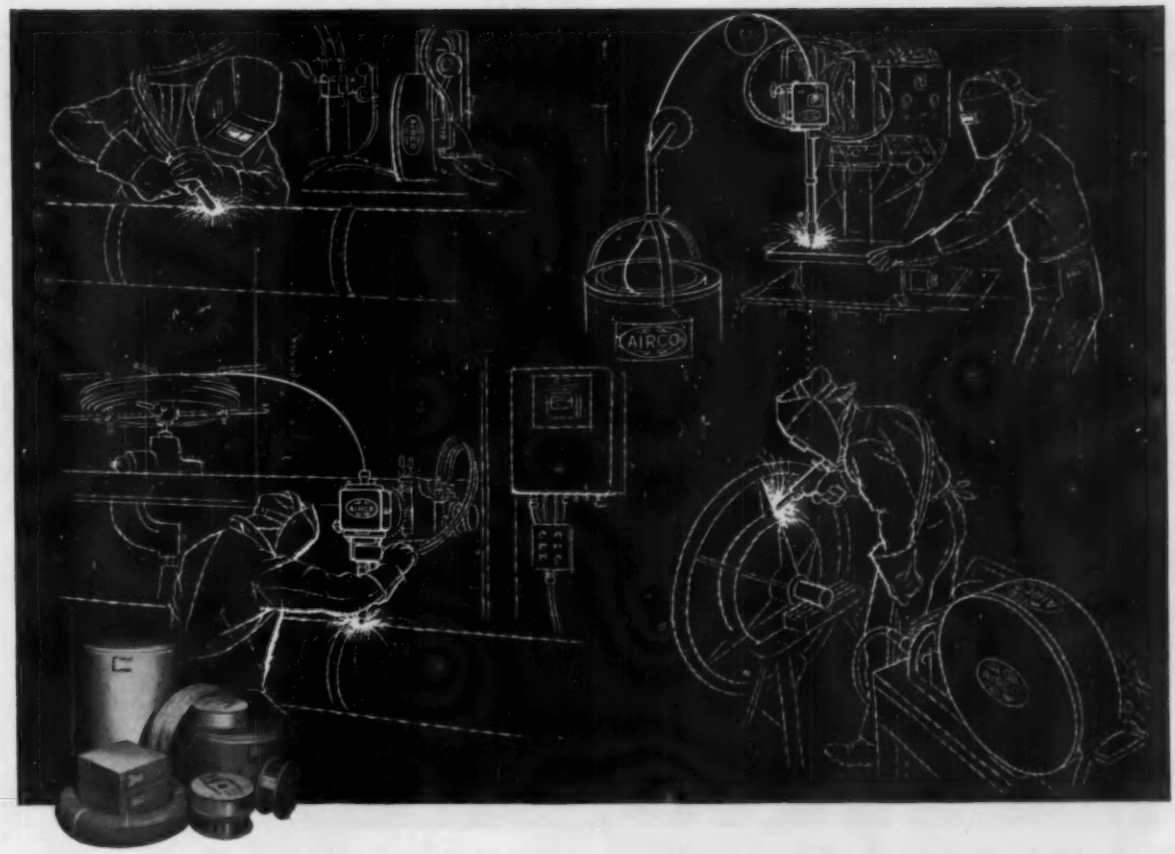
ASARCO

Division of

AMERICAN SMELTING AND REFINING COMPANY

120 Broadway • New York 5, N.Y.

In Canada: Federated Metals Canada, Ltd., Toronto and Montreal



THE WIDEST SELECTION OF AIRCOMATIC® WIRE

for any kind of inert gas welding

Successful Aircomatic welding and Heliwelding (where filler metal is required) depend on using the correct wire. Airco can supply the widest variety of wire types and diameters — all specifically designed for use with these inert gas shielded welding processes. All Aircomatic wires meet rigidly controlled specifications as to chemical analysis, surface finish, purity, cast and packaging.

Pure . . . properly cast . . . level wound

Aircomatic Aluminum Welding Wires. New Type A finish available for all high-quality work where X-ray standards must be maintained . . . scrupulously clean . . . bright finish . . . properly wound . . . smooth surface assures trouble-free feeding.

Aircomatic Stainless Steel Welding Wires . . . excellent corrosion resistance . . . good tensile, ductility and impact properties . . . use to weld ordinary joints, apply stainless linings, build-up stainless overlays and join stainless overlays and join stainless clad materials.

Aircomatic Copper and Copper Base Alloy Welding Wires. Use to assemble copper bus bars . . . fabricate copper or bronze vats . . . build-up worn propellers, piston and valve parts . . . available in both solid and stranded types.

Aircomatic Steel Welding Wires. Three grades available for welding mild steel, armor plate and for overlays and welding hardenable steels.

Nickel base, magnesium, and titanium wires are supplied as specials. Consult your nearest Airco Office or Authorized Airco Dealer for complete information.

AT THE FRONTIERS OF welding PROGRESS YOU'LL FIND . . .

AIRCO®

Offices and dealers in most principal cities

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated
150 East 42nd Street, New York 17, N. Y.

On the west coast — Air Reduction Pacific Company
Internationally — Airco Company International
In Cuba — Cuban Air Products Corporation
In Canada — Air Reduction Canada Limited

Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** — industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** — carbon dioxide — gaseous, liquid, solid ("DRY-ICE") • **OHIO** — medical gases and hospital equipment • **NATIONAL CARBIDE** — pipeline acetylene and calcium carbide • **COLTON** — polyvinyl acetate, alcohols, and other synthetic resins.

Companion machines that help each other and can help you!



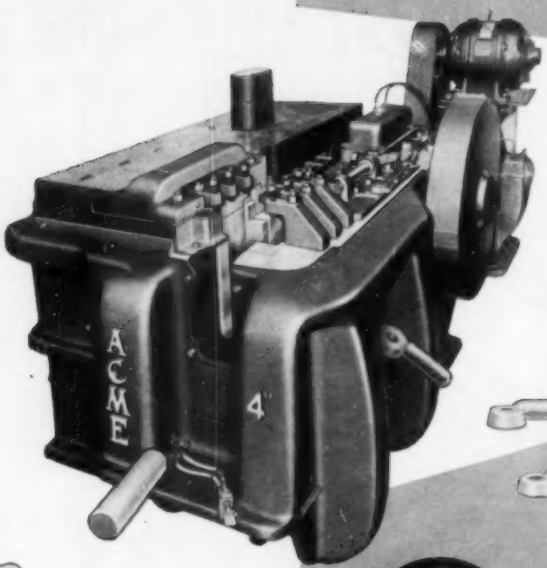
HILL ACME No. 700 BAR-BILLET shear
(Ask for Bulletin B-B)

HILL ACME BAR-BILLET SHEAR

A totally new conception of efficiency in clean, square cuts on bars or billets. Now proven in operation throughout the country. Made in several sizes for cutting stock from 1" to 6" in diameter.

ACME XN FORGING MACHINE

The new, improved ACME XN Forging Machine with its massive, sturdy construction is built to withstand the destructive influences present in all forging machine operations. ACME XN Forging Machines will keep going for long uninterrupted periods, producing accurate, clean forgings at a rate never thought possible a few years ago. A bulletin describing details plus a series of 18 technical articles on modern forging practice will be sent upon request.





HILL ACME TOOLS FOR INDUSTRY

The HILL ACME Company

1207 W. 65th STREET • CLEVELAND 2, OHIO

Manufacturers of: "ACME" FORGING • THREADING • TAPPING MACHINES • "CANTON" ALLIGATOR SHEARS • BAR-BILLET SHEARS
"HILL" GRINDING & POLISHING MACHINES • HYDRAULIC SURFACE GRINDERS • "CLEVELAND" KNIVES • SHEAR BLADES



"A FEW years ago, Benrus management issued instructions to convert our controlled atmosphere furnaces to the use of ammonia.

When the Armour Technical Service Department was consulted, we found the answers to our conversion problems promptly available. Armour supplied us with blueprints, engineering recommendations and a listing of suggested suppliers of ammonia tanks and systems. Plus all this, Armour also supervised the actual installation of the equipment.

You can bet that at Benrus, Armour Ammonia has an excellent record."

For 99.98% pure ammonia, backed by unexcelled technical service, call your nearest Armour sales office—or write directly to Chicago for complete information.

ARMOUR *Ammonia Division*

1355 West 31st Street • Chicago 9, Illinois



"At Du Mont, we cut costs with Armour Ammonia."

A. R. Dutcher
Purchasing Manager
Cathode-Ray Tube Division
Allen B. Du Mont Laboratories, Inc.

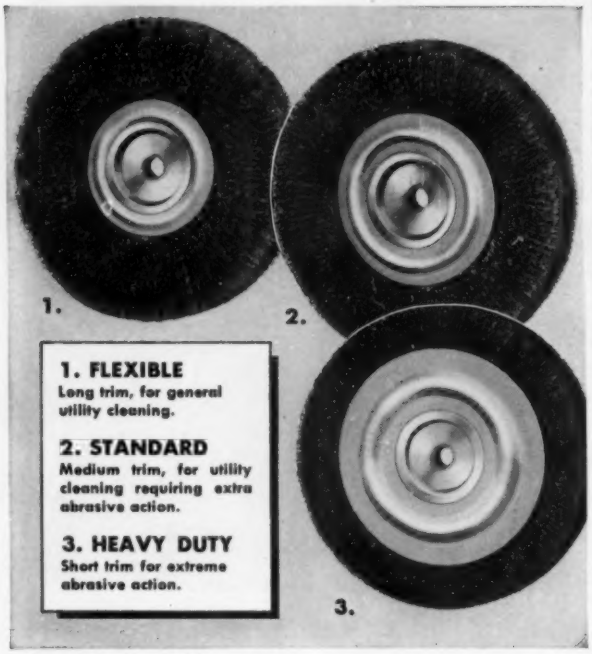


"Armour Ammonia helps Atwood meet strict customer specifications."

Wilhelm Olson, Metallurgist
Atwood Vacuum Machine Co.
Rockford, Illinois

Exact Brushing Surface and Strength for Every Brushing Job with...

Pittsburgh RED CENTER Brushes



Made with specific gauge, high-quality wire, mounted in specially designed hubs

● **Pittsburgh's Red Center** Power-Driven Brushes are built for heavy duty operation. Their distinctively colored hubs, with the exact surface and strength required, assure you precision brushing. They are constructed so accurately you get even distribution of wire around the hub. That's why you get longer brush life, faster cutting and finer finishing.

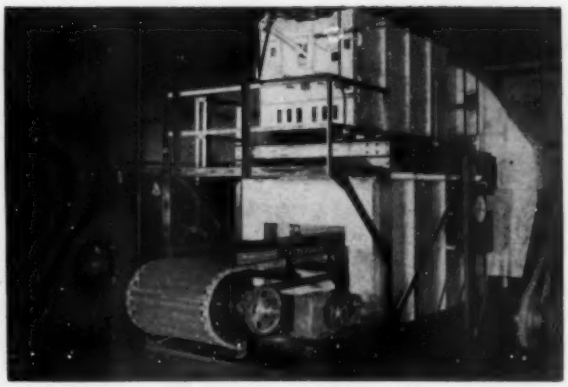
● **We have been solving** brushing problems in a wide variety of industries for many years. Our long experience in this field can save you time and money. Write Pittsburgh Plate Glass Company, Brush Division, Dept. MP-97, 3221 Frederick Avenue, Baltimore 29, Maryland.

PITTSBURGH *Power Driven* **BRUSHES**

BRUSHES • PAINTS • GLASS • CHEMICALS • PLASTICS • FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

IN CANADA: CANADIAN INDUSTRIES LIMITED



carl mayer Hi-Temp, Recirculating Type HEAT TREAT FURNACES

effect large savings in drawing, tempering, ageing, and heat treating of such products as bearings, billets, springs, screws, tools, gears, etc. in steel or aluminum. Continuous operation at temperatures up to 1200° F. Temperature uniformity guaranteed! Gas, oil, or electric fired.

Write for Bulletin HT-53

THE **carl mayer** CORP.

3030 EUCLID AVENUE CLEVELAND 15, OHIO

OTHER PRODUCTS: Core & Mold Ovens • Rod Bakers • Paint and Ceramic Drying Ovens • Special Processing Equipment & Accessories

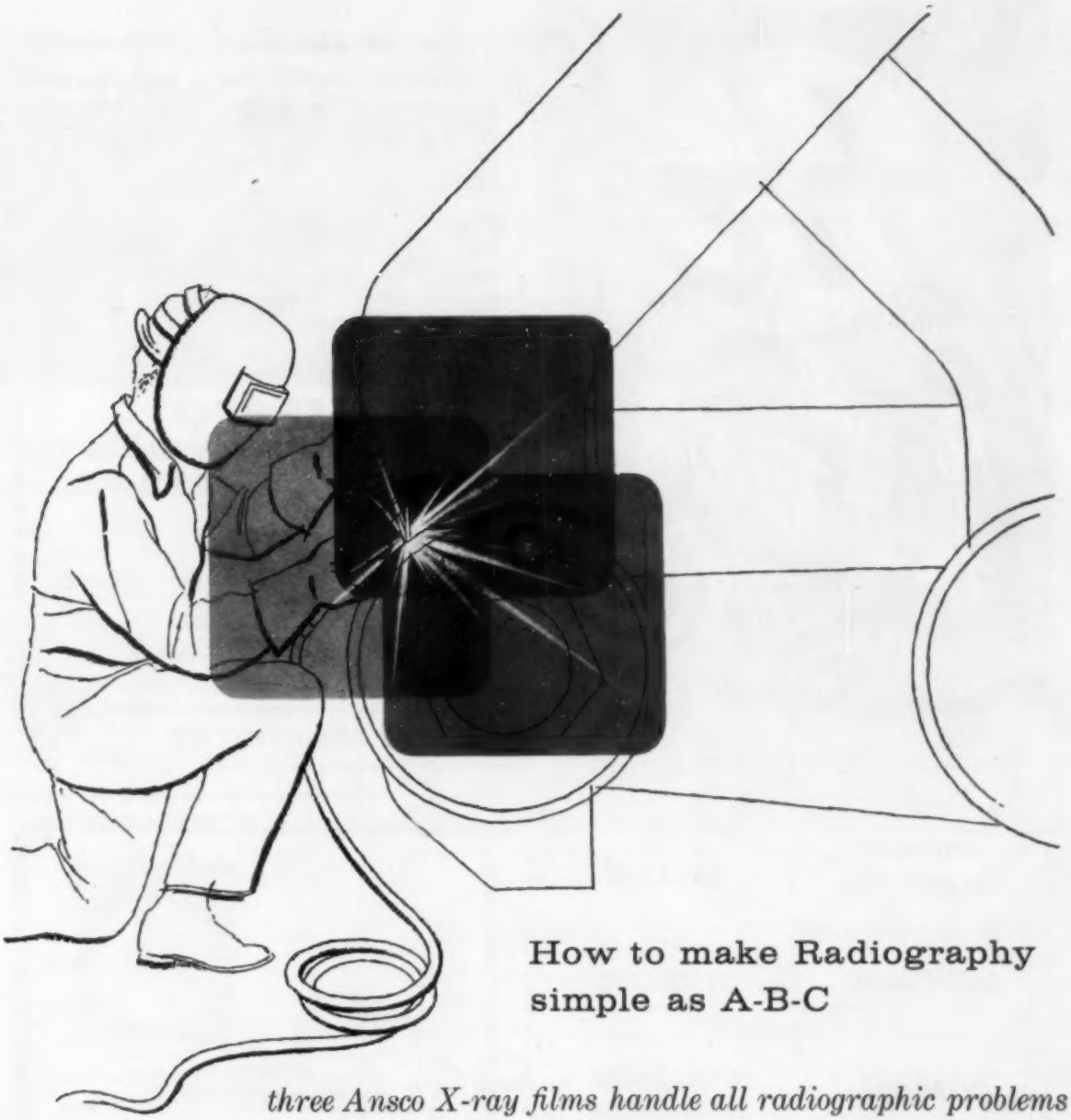
THE HARRIS TRANSDUCER Corporation

Woodbury, Connecticut

Designers and manufacturers of sonic and ultrasonic transducers and drivers for research and industrial applications.

Standard or custom designed or modular equipments to meet large or small scale requirements are supplied after careful scientific analysis to assure satisfactory performance. Our staff of Physicists, Electrical Engineers, and Industrial Process Engineers offer highly competent assistance on research, engineering and processing problems.

HTC



How to make Radiography simple as A-B-C

three Ansco X-ray films handle all radiographic problems

Superay "A" **Superay "B"** **Superay "C"**

Precision radiography becomes an easy matter with these three Ansco films. Even with the toughest radiographic problems you'll find the quality you are seeking with one of these.

Ansco Superay "A"—Fast fine grain industrial x-ray film recommended for most industrial applications. Superay "A" will record easy-to-read images in minimum times.

Ansco Superay "B"—Extreme contrast and highest resolving power make Superay "B" ideal for high voltage work and detecting minute flaws and discontinuities.

Ansco Superay "C"—This high speed film makes short work of routine inspection, can give you dramatic savings in testing costs, time, and labor.

Ansco offers you the best industrial films . . . and chemicals . . . for every X-ray need. *Let Ansco watch over your quality.*

Ansco

America's Oldest Maker of Photographic Materials

Binghamton, New York • A Division of General Aniline & Film Corp.

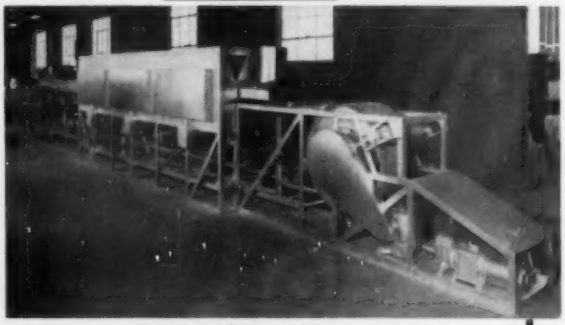
For all Heat Treating Jobs—

from 300°F. to 2500°F.

CARBURIZING	ANNEALING
NEUTRAL HARDENING	BRAZING
QUENCHING	DESCALING
NITRIDING	HIGH-SPEED HARDENING
TEMPERING	MARTEMPERING

HEATBATH
CORPORATION
Springfield 1, Mass.
or 701 North Sangamon Street, Chicago 22, Illinois
34 Years of Service to the Heat Treating and Metal Finishing Industry

Still in the Lead—with another versatile sectionalized belt furnace



PERECO
OXIDE REDUCTION FURNACE

- Composed of four self-contained, sectionalized units—drive and loading unit; high temperature zone; cooling section; and unloading and belt take-up assembly.
- Simple bolted assembly ready for operation, or disassembly—easily relocated for changing production schedules.
- All metal treating temperatures up to 2000° F. Belt speed variable from 5 ft. to 50 ft. per hr.
- Endless solid steel belt. Available with mesh conveyor with slight modification.
- Number and size of sections variable to meet individual time, temperature and production requirements.

Write Today For Details

Standard or Special Furnaces or Kilns for Temperatures from 450° F. to 5000° F.

PERENY EQUIPMENT COLUMBUS O

PERENY EQUIPMENT CO.
Dept. Q, 893 Chambers Rd., Columbus 12, Ohio



Here is a truly portable indicating recorder. We have redesigned our standard Thermo Electronic Recorder . . . making it 18 lbs. lighter . . . without sacrificing either accuracy, sensitivity or durability.

Available in 23 standard ranges from —400° up to 3000°F., it is also used to measure humidity, solution conductivity, speed, pH, direct current, DC voltage, power, strain, or any other measurement that can be converted to a change in resistance or DC millivoltage.

Interested? Write for catalog Section 60-100-H.

Thermo Electric Co. Inc.
SADDLE BROOK, NEW JERSEY
In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic.....Organic.....Decorative.....Protective

New type chromium plate improves products

Why Crack-Free Chromium gives superior finish

Regular chromium plate develops a network of cracks as it is deposited. Through these defects, corrosives reach the underlying metal. Deposits from the Unichrome Crack-Free Chromium Plating Process remain structurally sound and continuous. This explains the wide difference in degree of corrosion protection obtained.

OTHER PROPERTIES

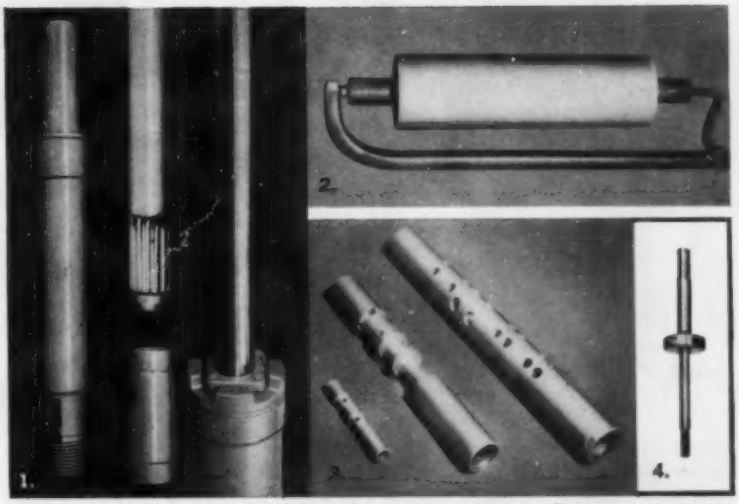
Crack-Free Chromium also provides:

1. Increased ductility, so that expansion and contraction cause no cracks.
2. Improved non-galling, non-seizing properties.
3. Low friction, resistance to wear.
4. Hardness (500 to 700 Knoop).
5. Excellent leveling action to help cover surface irregularities and reduce grinding needs.
6. Protection to the base metal without undercoats.
7. A satin matte *decorative* finish that can be applied directly to zinc die casting as well as steel. It buffs readily to high luster.

Bulletin CFC-2 gives more details on self-regulation and other features.

Unichrome is a trademark of Metal & Thermit Corp.

METAL & THERMIT
CORPORATION
General Offices: Rahway, New Jersey
Pittsburgh • Atlanta • Detroit
East Chicago • Los Angeles
In Canada: Metal & Thermit—United Chromium of Canada, Limited, Rexdale, Ont.



A few of the applications where Unichrome Crack-Free Chromium can be used to protect against corrosion, heat, wear. (1) Washer shafts and sleeve; hydraulic ram. (2) Roller. (3) Hyraulic control valve plungers. (4) Component part of power producing mechanisms.

Difficult problems created by heat, wear, corrosion solved by Crack-Free Chromium

Field reports confirm that Unichrome Crack-Free Chromium is truly a new type of chromium plate with valuable characteristics. It is being used in applications once thought impractical for chromium or other deposits.

IMPROVING HYDRAULIC SYSTEMS

On hydraulic rams, power steering shafts, hydraulic jacks being plated with Crack-Free Chromium, relatively thin deposits protect against corrosion, reduce friction and wear. Where aqueous hydraulic fluid penetrated the cracks in .003 to .005" of ordinary chromium, a .0009" Crack-Free deposit stopped it.

Washing machine and typewriter parts, spline shafts, piston rings, relay armatures are other applications where corrosion problems have been solved.

COMBATING THERMAL SHOCK

Spouts for pouring 2250°F. molten glass into molds last four times longer when plated with Crack-Free Chromium instead of ordinary chromium. Molds for TV tubes, subject to corrosion at the cracks in ordinary chromium, now last 5 to 10 times longer.

Increased ductility combines with resistance to thermal shock for other benefits. Faster, deeper grinding cuts can be made on this new chromium without fracture. On renewed transmission cams, this plate didn't fracture in service, whereas ordinary chromium did on 30% to 40% of the cams.

SLOWING DOWN WEAR

Crack-Free Chromium enables one user to increase life of textile machine rolls by 400% while cutting chromium deposit thickness 95%. It has also increased service life of drills, taps and reamers by 300%, compared with ordinary chromium.

Send for Bulletin CFC-2.

McDANEL CRUCIBLES

SERVICE TEMPERATURES TO 3000° F.



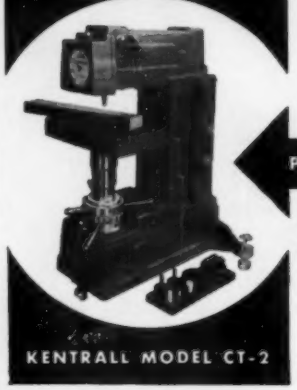
Check McDanel for High Temperature Laboratory Crucibles. Straight or tapered sides; specials, too, up to 2000 cc. Nonporous; resistant to neutral gases, air, CO_2, wet or dry hydrogen. Good thermal properties, temperatures to 3000° F. Resistant to basic and acid slags.

McDANEL Industrial CERAMICS

McDANEL
REFRACTORY PORCELAIN COMPANY
BEAVER FALLS · PENNSYLVANIA

---

2 Applications (REGULAR AND SUPERFICIAL) 1 Tester



KENTRALL MODEL CT-2

Hundreds of installations over the past few years have proved the economy of the only hardness tester which combines all scales of Rockwell Test (15 to 150 kg. loads).
The Kentrall cuts costs because it does the job of two conventional testers, requires only half the space and maintenance. Write for more detailed information, plus a list of prominent users who have switched to Kentrall. TB14B

PRICE $680.

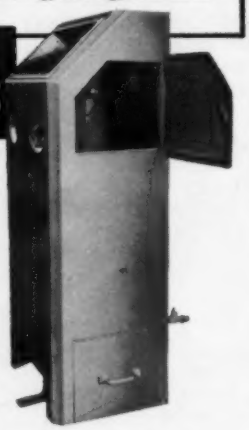
KENTRALL
THE TORSION BALANCE COMPANY
Main Office and Factory: Clifton, New Jersey
Sales Offices: Chicago, San Francisco

Save with Sandblasting!

Do all these operations better, faster, at lower cost with

- Cleaning metal surfaces, molds, dies, tools
- Removing burrs, scale, carbon, rust, paint
- Preparing surfaces for plating and finishing
- Producing satin and matte finishes
- Stenciling, lettering, trademarks

Cabinet Type LEIMAN SANDBLASTS



Whether you work on metal, glass, plastics, compositions . . . whether on production runs or single pieces, large or small—you'll find countless uses for versatile Leiman Sandblasts. Easily operated by unskilled help. Require little floor space. Use all types of abrasives. Well-designed, rugged, priced right, last for years.

Send for informative bulletin "Sandblasting", plus catalog showing complete line.

LEIMAN BROS., Inc. 116 Christie St., Newark 5, N. J.

NON DESTRUCTIVE MICRO-HARDNESS TESTER AND METALLURGICAL MICROSCOPE BY SHEFFIELD



This instrument determines hardness of precision-ground or lapped parts, fine wires, very thin sheet stock, cutting tool edges, ball bearing components as well as the more commonly tested parts.

Non-destructive because the indenting load ranges only from 25 to 1000 grams and the disturbance of the surface material is less than .000010". The spot to be indented can be located within .0002".

As a metallurgical microscope, magnifications of 200X and 400X are provided, with the option of using a camera for photomicrographs.

Write for Data Sheet to THE SHEFFIELD CORPORATION
Dayton 1, Ohio, U.S.A., Dept. 39.

7702

the **SHEFFIELD** *corporation*
measurement and measurement for mankind

BARBER COLMAN

Impressor

for quick, on-the-spot hardness testing of non-ferrous metals and plastics

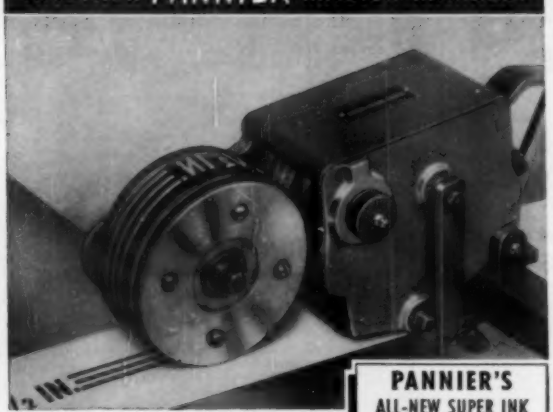


Simple to operate . . . gives an instant, dependable measure of hardness. Operates on principle of forcing a spring-loaded indenter into the surface with the amount of penetration registering on a dial indicator. Can be used in any position . . . tamperproof . . . compact . . . rugged, yet weighs only 12 oz. Thousands used by industry.

Write today for complete details.

BARBER-COLMAN COMPANY, Dept. U, 1218 Rock St., ROCKFORD, Illinois

ANOTHER *PANNIER* MASTER MARKER!



Super Ink Print-All clearly marks all conveyed materials traveling horizontally or vertically. It prints top or bottom surfaces as material moves under or over the printer.

Write for complete data.

PANNIER'S ALL-NEW SUPER INK PRINT-ALL

Internally fed unit.

Use inks from semi-paste to liquid, including light colored, heavy pigmented inks.

Continuous or repeat printing.

No stopping to add ink.

Print on 1" centers with multiple staggered units.

DIPTHMARKED MATERIALS

MARKING DEVICES

THE PANNIER CORPORATION

213 Pannier Building • FAirfax 1-5185 • Pittsburgh 12, Pa.

Offices: Los Angeles • Chicago • Cleveland • Philadelphia

"...need dry gas for your atmosphere furnace?"

REAL DRY GAS?



In an installation at Solar Aircraft Co., this small AIR-DRY dehydrator purifies all of the protecting and reducing atmosphere for the huge elevator type furnace shown above.



In conjunction with the above installation Solar Aircraft Co. has stated, *"We consider these drying units vital to the purification of hydrogen, used as a protective, reducing atmosphere in our production brazing process . . . "*

Not merely gas purification but *HIGH DEGREE* purification is the aim of our Engineering and Manufacturing Divisions. Laboratory precision combined with industrial ruggedness make AIR-DRY equipment the natural choice where dehydration or decontamination of *any* atmosphere is needed.

Whether your need is for fully automatic or for semi-automatic operation, AIR-DRY can produce a unit to comply with your specifications, *however exacting they may be.*

High or Low Pressure PURIFICATION and DEHYDRATION EQUIPMENT for all gases

AIR-DRY CORPORATION OF AMERICA

14756 KESWICK STREET, VAN NUYS, CALIFORNIA

Metal Progress

Taylor Lyman, *Publisher*

A. P. Ford, *Sales and Advertising Manager*

George H. Loughner, *Production Manager*
7301 Euclid Ave., Cleveland 3—UTah 1-0200

Regional Manager
JOHN B. VERRIER, JR.
342 Madison Ave., Room 1228, New York 17—Oxford 7-2667

District Managers

FRED STANLEY
342 Madison Ave., Room 1228
New York 17
Oxford 7-2667

WILLIAM J. HILTY
7301 Euclid Avenue
Cleveland 3, Ohio
Utah 1-0200

VIC D. SPATAFORA
53 W. Jackson Blvd.,
Chicago 4, Ill.
Wabash 2-7822

DONALD J. WALTER
20056 Livernois Street
Detroit 21, Mich.
University 4-3861

PUBLISHED BY AMERICAN SOCIETY FOR METALS, 7301 EUCLID AVE., CLEVELAND 3, OHIO—W. H. EISENMAN, SECRETARY

• Index to Advertisers •

Acheson Colloids Co. 22
Air-Dry Corporation of America 263
Air Products, Inc. 20
Air Reduction Sales Co., Inc. 255
Ajax Electric Co. 114
Aldridge Industrial Oils, Inc. 162
Allegheny Ludlum Steel Corp. 96C
Allied Chemical & Dye Corp.
Nitrogen Division 4
Allied Research Products Inc. 126
Alloy Engineering & Casting Co. 221
Alloy Metal Products, Inc. 49
Almco Division of Queen Stove Works, Inc. 240
Alpha Molykote Corp. 163
Aluminum and Architectural Metals Co. 182
American Brass Co. 38
American Chain & Cable
Wilson Mechanical Instruments Div. 43, 45
American Gas Association 217
American Gas Furnace Co. 251
American Instrument Co. 193
American Machine & Metals, Inc. 18
American Platinum Works 42
American Society For Metals 62, 63
Ampco Metal Inc. 129
Arco Steel Fabricators, Inc. 167
Armour & Co., Ammonia Div. 257
Armstrong-Blum Mfg. Co. 194
Ashworth Brothers, Inc. 33
Associated Spring Corp.
Wallace Barnes Steel Div. 222
Automotive Rubber Co., Inc. 169

Babcock & Wilcox Refractories Division 48
Baird-Atomic, Inc. 146
Baldwin-Lima-Hamilton 228, 229
Barber-Colman Co. 263
Bausch & Lomb Optical Co. 96D
Bede Products Corporation 192
Bell & Gossett Co. 236
Bethlehem Steel Co. 145, 245
Branson Ultrasonic Corp. 165
Bristol Co. 244
Buehler, Ltd. 17
Burrell Corp. 41
Byers Corp., A.M. 28

Cambridge Wire Cloth Co. 112
Cannon-Muskegon Corp. 54
Carborundum 141, 227
Carl-Mayer Corp. 258
Carlson Co., G.O. 58
Carpenter Steel Co. The 119
Central Foundry Division
General Motors Corporation 148, 149
Champion Rivet Co., The 128
Chemical Corp. 216
Cincinnati Sub-Zero Products Co. 172
Circo Equipment Co. 169
Clark Instrument Co. 25
Cleveland-Cliffs Iron Co., The 252
Climax Molybdenum Corp. 237
Cold Metal Products Strip Steel Div. 48B
Columbia-National Corp. 159
Consolidated Electrodynamics Corp. 140
Continental Industrial Engineers, Inc. 150
Crucible Steel Co. of America 55, 61
Curtiss-Wright Corp. 246

Darwin & Milner, Inc. 176
Detroit Testing Machine Co. 31
Dietert Co., Harry W. 180
Dow Furnace Co. 134
Drever Co. 34
Driver Harris Co. 199
Du-Lite Chemical Corp. 165
Du Pont de Nemours & Co., Inc. 50
Duraloy Co. 156

Eastman Kodak Co. X-Ray Div. 115
Electro Alloys Div. American Brake Shoe Co. 2
Electro Metallurgical Co.,
Unit of Union Carbon Corp. 57
Engineered Precision Casting Co. 168
Erico Products, Inc. 163

Fahralloy Co. 173
Federated Metals, Div. of
American Smelting & Refining Co. 254
Fenn Manufacturing Co. 118
Ferro Corp. 166
Finkl & Sons Co., A. 40
Foote Mineral Co. 116
Formed Steel Tube Institute 30

Gas Atmospheres, Inc. 24
General Alloys Co. 235
General Aniline & Film Corp.,
Ansco Division 259
General Electric Co. 189, 204, 205
General Extrusions, Inc. 168
Globe Steel Abrasive Co. 144
Glo-Quartz Electric Heater Co., Inc. 164
Gordon Co., Claud S. 216
Great Lakes Steel Corp. 202, 203
Gries Industries, Inc. 167

Haller, Inc. 167
Handy & Harman 238
Hanson-Van Winkle-Munning 248
Harbinson-Walker Refractories Co. 10, 11
Harnischfeger Corp. 253
Harris Transducer Co. 258
Harshaw Scientific Div.
Harshaw Chemical Co. 249
Hayes Inc., C. I. 36
Haynes Stellite Co., Unit of Union
Carbon Corp. 117
Heathath Corp. 260
Heavy Minerals Co. 142
Hevi Duty Electric Co. 124, 125
Hill Acme Co. 256
Holcroft & Co. 48A
Holden Co., A. F. 163
Hooker Electrochemical Co. 226
Hoover Co. 168
Hoskins Mfg. Co. 195
Houghton & Co., E. F. 197

Illinois Testing Laboratories, Inc. 187
Inductotherm Corp. 162
Industrial Heating Equipment Co. 130
International Nickel Co. 96A, 171
Ipsen Industries, Inc. 191

C. O. Jelliff Manufacturing Corp. 164
Jarrell-Ash Co. 23
Jessop Steel Co. 183
Jones & Laughlin Steel 8, 9, 179

Kemp Mfg. Co., S. M. 147
Kennametal, Inc. 160
King Tester Corp. 170
Kinney Mfg. Div. of N.Y. Air Brake Co. 122
Kux Machine Co. 213

L and L Manufacturing Co. 161
LaSalle Steel Company 133
Latrobe Steel Co. 175
Leeds & Northrup Co. 224, 225
Leiman Bros., Inc. 262
Lindberg Engineering Co.
Heat Treating Division 51, 52, 53
Little Falls Alloys, Inc. 163
Loftus Engineering Co. 186
Lucifer Furnaces, Inc. 162

Machlett Laboratories, Inc. 16
Magnethermic Corp. 123
Magnetic Analysis Corp. 167
Malayan Tin Bureau 198
Markal Company 212
Martindale Electric Co. 212
McDanel Refractory Porcelain Co. 262
Metal & Thermit Corp. 261
Metal Treating Equipment Exchange, Inc. 161
Michigan Crane and Conveyor 168
Minneapolis-Honeywell Regulator Co. 214, 215
Misco Fabricators, Inc. 31
Molybdenum Corp. of America 151

National Research Corp. 220
National-Standard Co. 127
Newage Industries, Inc. 29
New Jersey Zinc Co., Inc. 200
Nitrogen Division
Allied Chemical & Dye Corp. 4
Northwest Chemical Co. 231
Norton Co. 46

Oakite Products, Inc. 132
Ohio Crankshaft Co. 181
Ohio Steel Foundry 121
Olsen Testing Machine Co., Tinius 131

Pacific Scientific Co. 44
Pannier Corp. 263
Park Chemical Co. 201
Penn Precision Products, Inc. 21
Pereny Equipment Co. 260
Philips Electronics, Inc. 239
Pickands Mather & Co. 185
Picker-X-Ray Corp. of America 153
Pittsburgh Plate Glass Co., Brush Div. 258
Precision Tube Co. 198
Pressed Steel Co. 170
Production Specialties, Inc. 164, 168
Pyrometer Instrument Co. 35

Rameo Equipment Corp. 164
Republic Steel Corp. 14, 15
Revere Copper & Brass, Inc. 113
Riverside-Alloy Metal Div.,
H. K. Porter Co., Inc. 206
Rockwell Co., W. S. 39
Roll Coater, Inc. 166
Rolled Alloys, Inc. 158
Roll Formed Products Co. 167
Rolock, Inc. 152
Ryerson & Son, Inc., Jos. T. 64

Salem-Brosius, Inc. 177
Saunders & Co., Alexander 35
Sciaky Bros., Inc. 196
Selas Corporation of America 211
Sel-Rex Corp. 165
Seymour Mfg. Co. 250
Sharon Steel Corp. 32
Sheffield Corp. 262
Shore Instrument & Mfg., Inc. 168
Sieburg Industries, Inc. 167
Solventol Chemical Products, Inc. 166
Spencer Turbine Co. 139
Sperry Products, Inc. 190
Standard Fuel Engineering Co. 163, 169
Standard Steel Treating Co. 184
Stanwood Corp. 162
Star Stainless Screw Co. 163
Steel City Testing Machines, Inc. 5
Stokes Machine Co. 208, 209
Sun Oil Co. 26
Superior Tube Co. 232
Surface Combustion Corp. 6, 7
John Swift Chemical Co. 166
Sylvania Electric Products, Inc. 234

Technic, Inc. 164
Tempil Corp. 180
Thermo Electric Co., Inc. 260
Timken Roller Bearing Co. 137
Titanium Alloy Mfg. Div.
National Lead Co. 233
Titanium Metals Corp. of America 157
Torsion Balance Co. 168, 262
Tuco Products, Inc. 111

United Scientific Company 223
U.S. Industrial Chemicals Co. 210
U.S.I. Metals 242
USS Alloy Steel 241
United Wire & Supply Corp. 143
Upton Electric Furnace Co. 188
Utica Drop Forge & Tool Div.
Kelsey-Hayes Co. 135

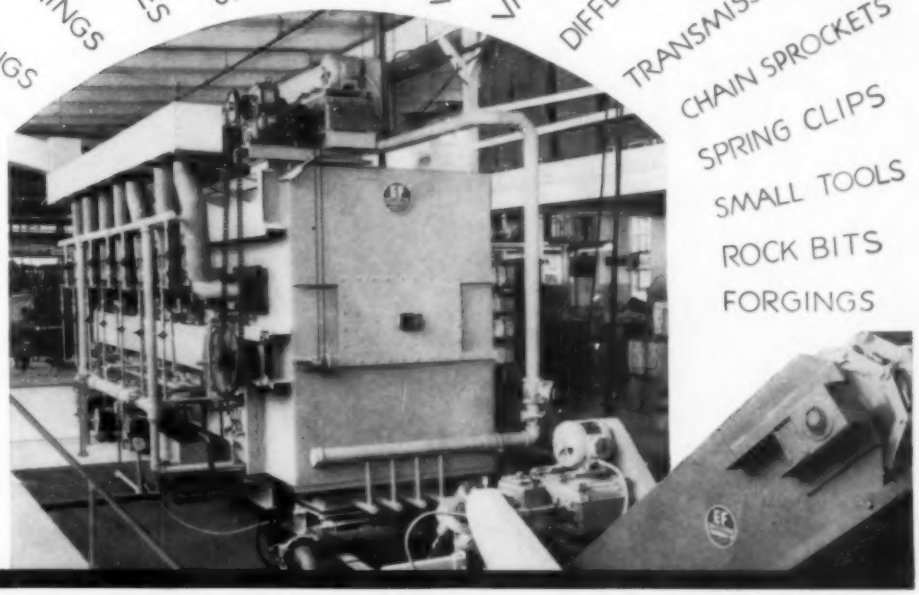
Vacuum Metals, Inc. 243
Vanadium Corp. 155
Vulcan Crucible Tool Steel, Div.
of H. K. Porter Company, Inc. 207

Waltz Furnace Co. 136
Washington Steel Corp. 247
Watson-Stillman Press Division 59
Waukee Engineering Co. 29
West Instrument Corp. 27
Westinghouse Electric Corp. 12, 13, 56, 218, 219
White Metal Rolling & Stamping Corp. 167
Wickwire Spencer Steel Div., of
Colorado Fuel & Iron Corp. 230
Wiley & Sons, Inc., John 174
Wilson Mechanical Instruments Div.,
American Chain & Cable 43, 45
Wiretex Manufacturing Co. 161
Wyckoff Steel Co. 138
Wyman-Gordon Co. 60

Yoder Co. 196
Young Bros. 178
Youngstown Welding & Engineering Co. 165

KABLE PRINTING CO.

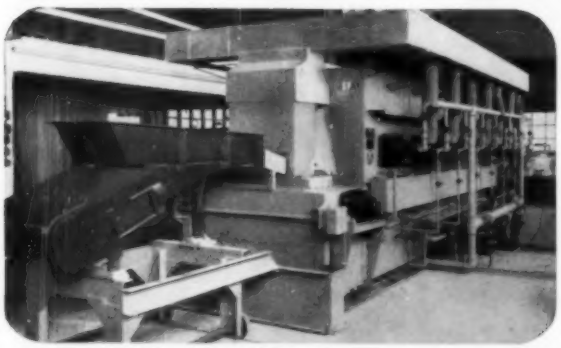
PARTS FOR BEARINGS
SPRING PLATES
CAP SCREWS
PINIONS
BOLTS - NUTS
RIVETS
WRENCH PARTS
VALVE SPRINGS
DIFFERENTIAL GEARS
TRANSMISSION GEARS
CHAIN SPROCKETS
SPRING CLIPS
SMALL TOOLS
ROCK BITS
FORGINGS
ROLLER BEARINGS
TRACTOR LINKS
AIRCRAFT PARTS
WASHERS
ENGINE PARTS
COIL SPRINGS



For Carbonitriding, Carbon Correction, Carburizing

Non-Decarb, Scale-Free Hardening and other Processes

Uniformly—Scale-free—Continuously, 175 to 2000 lbs. per hour



(Above) EF Gas Fired Radiant Tube Combination Hardening and Dry Cyaniding Unit Fitted with an Automatic Feeder that Distributes the Parts Evenly on the Chain Belt Conveyor; and a Dual Quench.

(View at top) The Conveyorized, Partitioned Dual Quench Moves Laterally to Permit either the Complete Oil or the Water Quenching Equipment to be Positioned under the Sealed Furnace Discharge.

• The EF chain belt conveyor furnace is one of the most satisfactory continuous heating units yet devised for scale-free hardening, carbon restoration, carbonitriding, carburizing and non-decarb heat treating small and medium size parts. The material is loaded onto our rugged heat resisting cast link conveyor belt; carried through the furnace; heated uniformly to proper temperature; automatically quenched and discharged. No pans or trays are needed. Hundreds in daily operation prove the dependability and efficiency of our design. 11 standard sizes. Capacities to 2000 lbs. or more per hour. Gas, oil or electrically heated. Furnished complete with any desired feeding, discharging or special atmosphere equipment. Write for folders describing our chain belt conveyor type and other production furnaces.

Ask for Bulletin 462-CB.

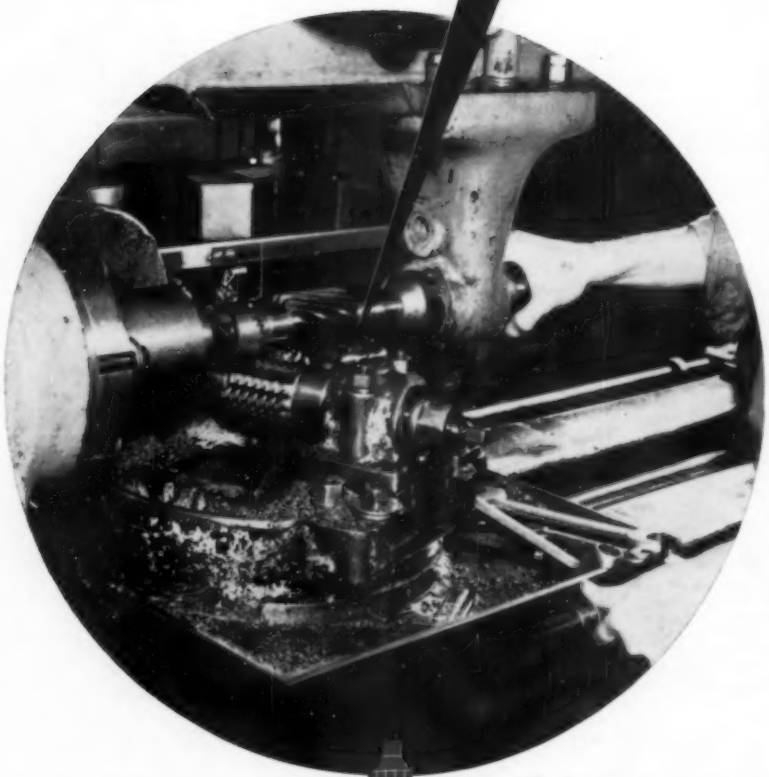
THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

Salem - Ohio

Canadian Associates • CANEFCO, LIMITED • Toronto 1, Canada

LEAD-LUBRICATED STEELS . . .



FOR "BUILT-IN" PRODUCTIVITY

Lead existing in alloy or carbon steels in the form of sub-microscopic particles acts as a natural lubricant. Its effect on your operating costs will be pleasantly surprising.

Faster speeds, faster feeds, better finish and longer tool life possible with these free machining steels are helping hundreds of manufacturers to increase production and to lower costs.

See what "lubricated" steels can do for you—specify leaded on your next Aristoloy order. Get the cost-cutting benefit of "built-in" productivity.

For further details,
write for free booklet,
"Lead Treated Steels."

ARISTOLOY STEELS

COPPERWELD STEEL COMPANY • WARREN, OHIO
Steel Division

EXPORT: Copperweld Steel International Co., 225 Broadway, New York 7, N. Y.